
UK Kidney Association Clinical Practice Guidelines for Peritoneal Access and Commentary on the 2019 (ISPD) Update for the Creating and Maintaining Optimal Peritoneal Dialysis Access

Final version:	July 2021
Review date:	July 2026

Authors

Bhriku Raj Sood (Lead author)

Consultant Nephrologist, South West Thames Renal and Transplantation Unit, Epsom and St Helier University Hospitals NHS Trust, Carshalton

Nicos Kessarlis

Consultant Transplant and General Surgeon, Guy's and St Thomas' Hospital, London, Honorary Consultant Great Ormond Street Hospital for Children, London, Honorary Senior Lecturer, King's College, London

Chris Reid

Consultant Children's Nephrologist, Evelina London Children's Hospital, London

Elaine Bowes

Senior Clinical Nurse Specialist in Peritoneal Dialysis, King's College Hospital NHS Foundation Trust, London

Acknowledgement

Hugh Cairns

Consultant Nephrologist, King's College Hospital NHS Foundation Trust, London

Contents

Introduction.....	4
Key	5
Commentary.....	6
Facilities	6
When to start PD	7
Timing of PD catheter insertion.....	8
Catheter selection	9
Catheter placement procedures/ Implantation techniques	13
Simultaneous abdominal surgical procedures	23
Hernia repair.....	23
Abdominal vascular prostheses	23
Gastrostomy tubes	24
Ongoing / day-to-day care and maintenance of PD access.....	25
Complications of peritoneal catheters	28
Infectious complications and management	28
Peritoneal leakage and management.....	30
Flow dysfunction and management	33
Catheter Removal.....	35
Secondary embedding.....	36
Audit	38
Definitions	39
Future direction and research	39
References.....	40

Endorsements



The National Institute for Health and Care Excellence (NICE) has accredited the process used by The UK Kidney Association to produce its Clinical Practice Guidelines. Accreditation is valid for 5 years from January 2017. More information on accreditation can be viewed at www.nice.org.uk/accreditation

Method used to arrive at a recommendation

The recommendations for the first draft of this guideline resulted from a collective decision reached by informal discussion by the authors and, whenever necessary, with input from the Chair of the Clinical Practice Guidelines Committee. If no agreement had been reached on the appropriate grading of a recommendation, a vote would have been held and the majority opinion carried. However this was not necessary for this guideline.

Conflicts of Interest Statement

All authors made declarations of interest in line with the policy in the UK Kidney Association Clinical Practice Guidelines Development Manual. Further details can be obtained on request from The UK Kidney Association.

Grading the evidence

The evidence for these recommendations has been assessed using the modified GRADE system. (5) The modified GRADE system defines both the strength of the recommendations of the guideline authors and the level of evidence upon which each of the recommendations is based. This grading system classifies expert recommendations as “strong” (Grade 1) or “weak” (Grade 2) based upon the balance between the benefits and risks, burden and cost. The quality or level of evidence is designated as high (Grade A), moderate (Grade B), low (Grade C) or very low (D) depending on factors such as study design, directness of evidence and consistency of results. Grades of recommendation and quality of evidence may range from 1A to 2D.

Authors reviewed the evidence and came to a collective decision on the guidance, with input from the chair of the guidelines committee as needed.

Introduction

The access to peritoneal dialysis (PD) and the utilisation of this modality as therapy for ESRF varies significantly within the UK. Timely and successful catheter placement remains a key variable. PD access failure and complications not only impact on PD utilisation, but also contribute to patient morbidity and poor patient experience. Clinical practice around the provision for creating PD access varies across the country and is highly dependent on the available expertise and facilities. Although there is a strong economic rationale in favour of PD over haemodialysis (HD), the potentially costly effect of PD technique failure is an important consideration, and can negate that economic benefit of PD.

We started this work to review the evidence and update the 2009 Renal Association Clinical Practice Guidelines for peritoneal access¹. In 2019 International Society for Peritoneal Dialysis (ISPD) published the guideline - "Creating and Maintaining Optimal Peritoneal Dialysis Access in the Adult Patient"². We have since then updated this document with added commentary on the ISPD guidelines.

There has been progress in improving techniques to provide PD access to the patients and significant number of publications looking at the outcome of the practice. ISPD update addresses various key issues in PD access, and we agree with and support the majority of the recommendations of the guideline. However, we realise that there are some key areas where the UK practice varies from the recommendation and the strength of the evidence does not support wide ranging change of practice. This commentary on ISPD guidelines on PD access describes supported key changes from previously published guidance. We have highlighted the areas of difference in practice, challenges in implementation, controversies and gaps in knowledge, and the suggested statement for implementation. There is paucity of good quality studies to support some of the recommendations in this document, and the available data is very heterogeneous. This limits the strength of some of the guidance. These aspects of PD access have been suggested as the focus for the audit and future research. Some aspects of care are supported by the best practice consensus amongst experts and might be driven by unique local expertise. Adoption of these recommendations should be supported by local audit process to ensure that the success of these techniques can be reproduced.

This document replaces all previously published Renal Association (RA) guidelines on the topic. In each case, we have included the guideline from the original Renal Association 2009 Guidelines on Peritoneal Access³ followed by the comments on the updated recommendation or suggestion from the 2019 ISPD Update, and a summary of the rationale based on the review of available literature behind each recommendation.

In addition to reviewing the PD access in adult patients, this document also addresses some key differences in practice in providing PD access in the paediatric population. PD is widely utilised to manage ESRF in children because the simplicity of the procedure which allows for dialysis at home in all but the most exceptional circumstances, thereby returning the child with ESRF to regular school attendance and facilitating normal family and childhood activities.⁴

The format of the commentary is as follows:

Each individual recommendation has the previous RA 2009 guidance; the ISPD 2019 updated guidance followed by the UK Kidney Association (UKKA) comment/guidance, and then the summary of the rationale/evidence for update. Section on Paediatric guidance is added where there is a specific difference from the adult practice.

2009 RA	2009 RA Guidelines
2019 ISPD	2019 ISPD Guideline
2021 UKKA	2019 UK Kidney Association (UKKA) guidance
2021 UKKA-P	2019 UKKA guidance on paediatric PD access

Key

PD – Peritoneal dialysis

PDC – Peritoneal dialysis catheter

ISPD – International Society of Peritoneal Dialysis

RA – Renal Association

HD – Haemodialysis

ESRF – End-Stage Renal Failure

AKI – Acute Kidney Injury

aPD – assisted Peritoneal Dialysis

RCT – Randomised controlled trial

Commentary

Facilities

2009 RA	PD Access: Access Team <ul style="list-style-type: none"> We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters (1C).
2019 ISPD	No specific recommendation
2021 UKKA	PD Access: Access Team <ul style="list-style-type: none"> We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters. (1C). We would recommend that at the core of this team there should be a lead nurse, nephrologist and surgeon who take the responsibility of running a successful team with regular MDMs, audits and governance structure. (1C). We recommend that an access team should be developed to allow the provision of urgent PD catheter insertion to patients presenting late to the renal service (1C).

Rationale/ evidence

The access team should comprise nurses, nephrologists and surgeons who have experience in PD. Each member of the team should understand the importance to the patient of successful access placement and the need for attention to detail in the reduction of complications.⁶ There should be a lead nurse, nephrologist and surgeon who take the responsibility of running a successful team with regular MDMs, audits and governance structure. A well led team with focus on standardisation of procedures, education and training for operating theatre environments and harmonising activity to support a safer environment for patients, can significantly reduce harm and improve success.⁷

Late presentation to the renal services with advanced CKD remains a barrier to access to home therapies.⁸ Renal units should develop PD access teams to provide timely urgent insertion of PD catheters. These should include an operator to insert the PD catheter, a nephrologist to prescribe dialysis and trained nursing team to provide peritoneal dialysis on the ward.

When to start PD

2009 RA	No specific recommendation
2019 ISPD	No specific recommendation
2021 UKKA	There is no advantage of starting PD early vs late with eGFR 5-7 ml/min
2021 UKKA-P	<ul style="list-style-type: none"> Acute peritoneal dialysis can be used in children with AKI for example, after cardiac surgery (2C). Early referral to a paediatric nephrology centre, certainly by CKD stage 3, enables access to specialist care; improved management of anaemia, proteinuria, BP, and renal bone disease/growth; and allows forward planning for pre-emptive transplantation, or for planning dialysis modality (1C).

Rationale/ evidence

The primary determinant for the time to insert PD catheter is the renal function at the start of dialysis. The appropriate time to start dialysis has been debated over years. There has been an increase in the early start of dialysis⁹, including in patients starting PD.¹⁰

Although observational studies had indicated some benefit of early start of dialysis, a randomised controlled trial (IDEAL Study) in 2008 did not show any benefit of starting early (eGFR 10-14ml/min) as compared to late (eGFR 5-7ml/min) (hazard ratio for death in the early-start group, 1.04; 95% CI, 0.83 to 1.30; P=0.75), although the early start group had a lower than intended eGFR (9ml/min against intended start between 10 – 14ml/min) and there was less separation of eGFR in the 2 groups (9/min in early start and 7.2ml ml/min in late starters).¹¹ 50% of the patients in the early start group and 44% in the late start group started RRT with PD. Subgroup analysis of the patients starting PD showed no difference in overall outcomes, including peritonitis rates. In another study a significant difference was in the proportion of patients planning to commence PD who actually initiated dialysis with PD, which was higher in the early-start group (80% vs 70%, p = 0.01).¹²

There is limited data comparing urgent start PD to HD. In a trial, urgent start PD in patients presenting late with ESRF has been shown to have lower incidence of early complications than urgent start HD, despite being a more co-morbid patient group, although there was no significant difference in the patient survival.¹³

In children, retrospective studies have shown no differences in mortality rates between different modalities of renal replacement therapy. Peritoneal dialysis is a simple and low-cost technique that can be used in all ages to treat ESRF as well as AKI, such as in neonates following heart surgery for congenital heart disease.¹⁴

Timing of PD catheter insertion

2009 RA	PD Access: Timing and co-ordination of referral and surgery <ul style="list-style-type: none"> We suggest, whenever possible, that catheter insertion should be performed at least 2 weeks before starting peritoneal dialysis. Small dialysate volumes in the supine position can be used if dialysis is required earlier
2019 ISPD	Catheter break-in procedures <ul style="list-style-type: none"> We recommend a break-in period of at least 2 weeks before elective start on PD (1B). We recommend a modified PD prescription using low volume exchanges with the patient in the supine position if urgent start on PD with a break-in period of < 2 weeks is needed (1C).
2021 UKKA	Agree with the ISPD guidelines
2021 UKKA-P	Agree with the ISPD guidelines

Rationale/ evidence

One randomized trial¹⁵, a number of observational studies^{16,17,18,19} and many smaller mainly retrospective single-centre studies have constantly shown that urgent start on PD with a break-in period of less than 2 weeks may be associated with a minor increased risk of mechanical complications but no apparent detrimental effect on patient survival, peritonitis-free survival, or PD technique survival when compared with elective start on PD.

As intraperitoneal pressure is linearly related to dwell volume and is increased in the upright position, we recommend that where possible, a modified PD prescription using low dwell volumes with the patient in the supine position to minimize the risk of leakage if urgent start on PD is needed.²⁰ Although a RCT comparing outcome for patients starting full volume (2000ml) exchanges to the patients starting low volume exchanges slowly increased over 13 days, found no difference in early or late complications, as well as 1 year catheter survival in both groups.¹⁹

There is no evidence to support any particular catheter type or insertion technique in patients needing early start.

Early use of PD catheter in children can be limited by dialysate leakage or catheter obstruction due to omentum. The chance of fluid leakage around the wound can be reduced by tightly securing a purse string suture around the catheter where it enters the peritoneal cavity as well as by using a lower dwell volume for a few days after catheter insertion. In addition, fibrin sealants can be used to reduce the risk of leakage.¹⁴

Catheter selection

<p>2009 RA</p>	<p>PD Access: Facilities</p> <ul style="list-style-type: none"> • We suggest that no particular catheter type is proven to be better than another (2C). • We suggest that a catheter of a suitable size should be used (2C).
<p>2019 ISPD</p>	<p>Catheter selection for chronic PD</p> <ul style="list-style-type: none"> • We recommend catheters made of silicone rubber (1B) • We recommend that standard catheters be provided with double Dacron (polyester) cuffs (1C) • We recommend the use of catheters with either a straight or coiled tip with either a straight segment or preformed arc bend in the inter-cuff section (1C) • We recommend the use of an extended catheter for remote exit-site location when standard catheters are unable to provide both optimal pelvic position and satisfactory exit-site location (1C) • Catheter choice should produce a satisfactory balance of pelvic position of the tubing tip, exit-site in a location that minimizes the risk of infection and is easily visible and accessible to the patient, and resulting in minimal tubing stresses during the course of its passage through the abdominal wall (not graded). • We recommend that the PD access team be familiar with a basic inventory of catheter types that permit selection of the most appropriate device based upon body habitus and clinical conditions (1B). • We recommend that the PD team develop a protocol for preoperative mapping to select the most appropriate catheter type from their inventory of devices (1C).
<p>2021 UKKA</p>	<p>Agree with ISPD guidance – except for</p> <ul style="list-style-type: none"> ○ No difference in catheter outcome between single of double cuff catheters, so can be considered in circumstances where there is less space for creating long enough tunnel for double cuff catheters. (2B) ○ Straight or self-locating catheter can be considered in patients with repeat catheter malposition (2B)
<p>2021 UKKA-P</p>	<ul style="list-style-type: none"> • Use of double cuff coiled catheter is recommended in children, with correct catheter size chosen by surgeon for size of child or infant (1C).

Rationale/ evidence

Because patients present with a range of body sizes and shapes with a variety of medical conditions, one catheter type cannot be expected to fit all²¹. Choice of catheter type should take into consideration the patient's belt line, obesity, skin creases and folds, presence of scars, chronic skin conditions, intestinal stomas, suprapubic catheters, gastrostomy tubes, incontinence, physical limitations, bathing habits, and occupation.

A recent Cochrane Review on type of catheter as well as insertion techniques for preventing catheter-related infections, no particular PD catheter type or method of insertion was shown to be better in preventing catheter-related infections in peritoneal dialysis patients. Studies included were not of sufficient size or duration to evaluate outcomes such as technique and patient survival long term.²²

Catheter material

Currently, most chronic catheters are constructed of silicone rubber. A polyurethane catheter that ceased production in 2010 was made of a particular polymer extremely susceptible to oxidative stress fractures, softening, and rupture due to chronic exposure to polyethylene glycol present in mupirocin ointment used for long-term catheter exit-site prophylaxis²³. Erosion of silicone catheters due to the use of gentamicin cream at the exit site has been reported but appears to be a rare complication²⁴.

Catheter configuration

There are several variations to the peritoneal catheter design that claim superiority over the others. The most usual variations concern the number of cuffs (single or double), the design of the subcutaneous tunnel (swan neck or straight/ Tenckhoff), and the shape of the intra-abdominal portion (straight or coiled). A weighted self-locating catheter with 12g tungsten weight at the tip of catheter has been developed in attempt to reduce catheter migration.

Straight catheter might be better than the coiled tip catheter with fewer mechanical complications (2B)

Studies have shown conflicting results with some finding no difference in rates of catheter migration or function. Two meta-analyses suggest better catheter survival for straight tip catheters^{18,25}, but the outcome of the catheters was determined by other causes of catheter removal in addition to the mechanical failure. A recent RCT also demonstrated better outcomes with straight tip catheters²⁶.

Straight or swan neck catheter have no difference in complications rates

Subcutaneous segment of the catheter could be straight or pre-bent in the swan-neck catheter. The design of the Swan neck catheter provides an exit site directed caudally from a subcutaneous tunnel and an internal entrance from the tunnel directed caudally into the peritoneal cavity, and is expected to reduce the exit site infection and cuff migration. Some studies have showed slightly lower^{27,28} or a higher²⁹ incidence of ESI, although not statistically significant. Meta-analysis of 5 studies with 313 patients did not demonstrate any significant difference in the rates of ESI, tunnel infection or peritonitis, and did not demonstrate any impact on the catheter migration.²⁵

Number of cuffs does not offer any benefit (2C)

Dacron cuffs glued to the catheter encourage fibrosis around catheter and provide anchorage to the catheter. The idea behind the double cuffs was to reduce the peri-catheter transmission of organisms to the peritoneum. Single randomised trial showed no benefit in having 2 cuffs over a single cuff catheter in reducing the incidence of first instance of peritonitis or ESI³⁰, although observational data from Canadian database has suggested some benefit in reducing the peritonitis with the use of double cuff catheter, but the benefit seemed to have vanished in more recent observation in patients having catheter insertion since 2001, which the authors attributed to improved overall care of the exit site and thus reduced organism burden³¹.

Extended/ Pre-sternal catheter should be considered for selected patients

An alternative peritoneal catheter exit-site location is sometimes needed in patients with obesity, floppy skin folds, chronic yeast intertrigo, intestinal stomas, urinary and faecal incontinence and children with diaper. Two-piece extended catheters permit remote exit-site locations away from these problematic abdominal conditions. The pre-sternal peritoneal dialysis catheter is composed of two flexible (silicon rubber) tubes joined through a titanium connector at the time of implantation. The device has been dubbed as a "bath tube" catheter because, with the exit on the chest, a patient may take a tub bath without the risk of exit contamination due to submersion. Many patients prefer pre-sternal catheter because of better body image.³² Some users have extended tunnel to as far as back of the patient to help some patients with behavioural disturbances, who are prone to pull or snatch at lines.³³

A non-randomised study, where the choice of exit site was based on patient characteristics, showed time until first exit-site infection was longer for extended catheters, and although there was no difference in exit site, subcutaneous tunnel, and peritonitis infection rates; the proportion of catheters lost during peritonitis episodes was significantly greater for extended catheters. This was attributed to interactions of body mass index (BMI) and diabetic status in determining catheter loss from peritonitis for both catheter types, the factors which also determined the choice of exit location in this study.³⁴

The chest has been used sparingly as an exit site in the paediatric population in the past.^{35,36}

Self-locating catheter can reduce catheter malfunction (2C)

A catheter with a tungsten (Wolfram) weight was developed to reduce the rates of catheter malfunction due to catheter migration. Non randomised observational studies have suggested advantage of this catheter in reducing catheter tip dislocation³⁷. Two randomised controlled studies compared the outcomes of a SLC compared to straight Tenckhoff PD catheters^{38,39} and both studies suggested significantly reduced mechanical drainage problems with SLCs. In the first study, 7 of 32 inserted straight Tenckhoff catheters and none of 29 self-locating Wolfram catheter required repeat surgery for catheter malfunction³⁸. In the second larger study showed the malfunction risk 4 times higher for TCs as compared to SLCs³⁹.

Pre-operative mapping improves catheter survival / reduces complications (1D)

There is no study data to support pre-operative mapping, but it has been demonstrated by computerized tomographic (CT) peritoneography that 30% – 55% of dialysate rests in the pelvis when the patient is supine⁴⁰, thereby supporting the concept of preferably positioning the catheter tip in the pelvis for optimal

hydraulic function . It is the catheter insertion site and the length of intraperitoneal tubing that determines the pelvic position of the catheter tip.^{41,42}

Exit Site location

The patient should be examined in a sitting position to verify that the selected exit site is easily visible to the patient, not located within the belt line, inside a skin crease, or on the blind side or apex of an obese skin fold. If needed, long single segment⁴³ or double segment catheters^{44,34} can be used to remotely locate the exit site away from the problematic lower abdominal region to the upper abdomen or upper chest while maintaining optimum position of the catheter tip.

Catheter placement procedures/ Implantation techniques

<p>2009 RA</p>	<ul style="list-style-type: none"> • We recommend that each centre should have a dedicated team involved in the implantation and care of peritoneal catheters (1C) • We recommend that renal units should have clear protocols for peri-operative catheter care including the use of antibiotic prophylaxis (1A). • We recommend that a dedicated area should be used for catheter insertion with appropriate staffing, suction, oxygen and patient monitoring facilities (1A). • We recommend that local expertise at individual centres should govern the choice of method of Peritoneal Dialysis (PD) catheter insertion (1B). • We suggest that PD catheters should be inserted as day case procedures as long as this does not compromise the quality of care. (2C).
<p>2019 ISPD</p>	<ul style="list-style-type: none"> • Adherence to a number of best practice details (Table 1) is essential in creating a successful long-term peritoneal access irrespective of the catheter implantation approach (not graded) • Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise (not graded) • We recommend that laparoscopic PD catheter implantation employ advanced adjunctive procedures that minimize the risk of mechanical complications (1C) • We recommend that percutaneous needle-guidewire insertion of PD catheters utilize image guidance (ultrasonography and/or fluoroscopy), when such means are available, to improve outcomes and minimize complications (2C)
<p>2021 UKKA</p>	<ul style="list-style-type: none"> • Follow National/Local guidelines for reducing risk of COVID-19 infection during the Pandemic (1A). • Single preoperative dose of prophylactic antibiotic to provide anti-staphylococcal coverage (1A) • Units should promote development of both percutaneous and surgical PD catheter insertion to improve patient choice and timely insertion of PD catheter (1C) • Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise (1C) • Units should have multi-disciplinary approach in the formulation of a patient-centred care plan to optimise PD catheter outcomes, especially in the complex patients (1C)

	<ul style="list-style-type: none"> • Procedure team should adhere to Five Steps to Safer Surgery and WHO checklist or National/Local Safety Standards for Invasive Procedures. (1A). • It would be preferable that percutaneous needle-guidewire insertion of PD catheters utilize image guidance (ultrasonography and/or fluoroscopy), when such means are available, to minimise complications, but there is no data to support its superiority over blind insertion (2D) • We recommend that surgeons using laparoscopic PD catheter implantation are trained to employ advanced adjunctive procedures (omentectomy, epiploectomy, adhesiolysis etc.) as necessary, to minimize the risk of mechanical complications (1C)
2021 UKKA-P	<ul style="list-style-type: none"> • Subtotal omentectomy is recommended in all children who undergo open or laparoscopic PD catheter insertion. (1B)

Table 1 (As in ISPD 2019 guidelines)

Best Practices in Patient Preparation and Peritoneal Catheter Implantation
<ul style="list-style-type: none"> • Preoperative assessment performed by a multidisciplinary peritoneal dialysis access team to select the most appropriate catheter type, implantation technique, insertion site, and exit-site location²¹ • Implement bowel program to prevent perioperative constipation^{45,46} • Follow National/Local guidelines for reducing risk of COVID-19 infection during the Pandemic⁴⁷ • Shower on the day of procedure with chlorhexidine soap wash of the planned surgical site⁴⁸ • If hair removal is necessary, use electric clippers⁴⁸ • Empty the bladder before procedure; otherwise, Foley catheter should be inserted if the bladder is still full⁴⁹ • Single preoperative dose of prophylactic antibiotic to provide anti-staphylococcal coverage⁵⁰ • Should adhere to Five Steps to Safer Surgery & WHO checklist and National/Local Safety Standards for Invasive Procedures^{51,52} • Operative personnel are attired in cap, mask, sterile gown, and gloves and ensure strict aseptic technique at all times⁴⁸ • Surgical site is prepped with chlorhexidine-gluconate scrub, povidone-iodine (gel or scrub), or other suitable antiseptic agent and sterile drapes applied around the surgical field⁴⁸

Table 1 continued

Best Practices in Patient Preparation and Peritoneal Catheter Implantation

- Peritoneal catheter is rinsed and primed with saline and air squeezed out of the Dacron cuffs by rolling the submerged cuffs between fingers⁵³
- Midline or para-median approach can be used for the insertion of the catheter. Surgical practice is to bury the medial cuff deep within or below the rectus muscle. Cuff should not be intraperitoneal. Percutaneous insertion methods leave the cuff superficial to the rectus sheath/ muscle. This makes it easier to remove the catheter under local anaesthetic. This approach should be considered for surgical insertions too^{54,55}
- Aim for a pelvic location of the catheter tip⁵⁶
- Subtotal omentectomy should be performed in children^{57,58,59,60,61}
- Placement of purse-string suture(s) around the catheter at the level of the peritoneum and posterior rectus sheath and/or the anterior rectus sheath, when the catheter is inserted through open surgical technique
- Additional sutures should be used in children to reduce the risk of hernia formation^{62,63,64,65,66,67}
- Subcutaneous tunnelling instrument should not exceed the diameter of the catheter⁶⁸
- Catheter flow test performed to confirm acceptable function
- Exit site located more than 2cm beyond superficial cuff⁶⁹
- Skin exit site directed lateral or downward^{70,53}
- Exit site should be smallest skin hole possible that allows passage of the catheter⁶⁸
- No catheter anchoring sutures at the exit site (use medical liquid adhesive and sterile adhesive strips to secure the catheter)
- Attach dialysis unit's requested catheter adapter and transfer set at time of procedure
- Flush catheter with saline/ heparinised saline/ dialysis fluid at the end of the procedure
- Exit site protected and catheter immobilized by self- adhesive non-occlusive breathable dressing⁷¹

Rationale/ evidence

Best practice details in Table 1 have been distilled through decades of observations by expert practitioners. Only a few steps have any good quality evidence to support them, but have ample common sense, observational data and expert opinion to support their routine use. It is advised that the practitioner be aware of deviations from recommended practices and be alert for the potential complications that may arise from such departures.

Safe procedure

WHO Safer Surgery Checklists greatly improve the delivery of safer care for patients undergoing operations. This approach can be extended beyond surgery towards all invasive procedures performed in hospitals. Although the checklists in themselves cannot be fully effective in protecting patients from adverse incidents, when conducted by teams of healthcare professionals who have trained together and who have received appropriate education in the human factors, these help underpin safe teamwork. Local Safety Standards for Invasive Procedures (LocSSIPs) should be created by multi-professional clinical teams and their patients, and implemented against a background of education in human factors and working as teams to provide a safe PD access procedure to the patients.^{51,52}

Prophylactic antibiotic

Infection related complications are the leading cause of PD technique failure necessitating conversion to HD. Most studies demonstrate benefit of prophylactic antibiotic use before PD catheter insertion in reducing the incidence of infectious complications with antibiotics including vancomycin^{50,72}, cefazolin⁷³, gentamycin⁷⁴, while one study using cefazolin and gentamicin found no benefit⁷⁵. A randomised controlled trial demonstrated superiority of the use of IV vancomycin to both using IV cefazolin or not using any antibiotic prophylaxis⁵⁰. A recent Cochrane review concluded that pre/peri-operative intravenous vancomycin may reduce the risk of early peritonitis in the first few weeks (< 1 month) following Tenckhoff catheter insertion but has an uncertain effect on the risk of exit-site/tunnel infection. The comparisons using other antibiotics (i.e. IV gentamicin; IV cefazolin plus gentamicin; IV cefuroxime plus cefuroxime intraperitoneal) did not reduce the risk of peritonitis or exit-site/tunnel infection⁷².

There is no data on the use of anti-microbial impregnated dressing for exit site care after catheter insertion, although some units use it routinely. The exit site care following PD catheter insertion should follow ISPD guidelines on prevention of infection related complication and local protocol.⁷⁶

Antibiotics are also necessary in the paediatric population undergoing PD catheter insertion.⁷⁷

Catheter Insertion technique

A significant variation in practice is observed in the UK with regards to PD access (UK Renal Registry 20th Annual Report: 2016 Multisite Dialysis Access Audit in England, Northern Ireland and Wales and 2015 Peritoneal Dialysis One Year Follow-up: National and Centre-specific Analyses). Twenty-three centres reported use of non-surgical PD catheter placement, accounting for 35.3% of all catheters placed and 17 of these centres placed 50% of their PD catheters this way. Five centres placed 90% of their PD catheters percutaneously.⁷⁸ Similar practice variation was also observed in the recent UK Catheter cohort Study as

presented in the joint ISPD/EuroPD (International Society and European Societies for Peritoneal Dialysis) conference.⁷⁹

ISPD guidance (Table 2) recommends advanced laparoscopic procedure as a preferred technique for PD catheter insertion over other techniques. In patients with previous abdominal surgery, percutaneous PD catheter insertion is not recommended. **This is where the UK practice varies from the ISPD recommendation.** A lot of UK centres use percutaneous PD catheter insertion as a preferred method for PD access in patients. In some centres, this technique, especially with image guidance, is also used to insert catheters in patients with previous history of abdominal surgery or peritonitis too. ISPD guidance suggests advanced laparoscopic technique as a preferred technique where there is no contraindication to the anaesthesia. The use of percutaneous technique is only recommended in selected situations where there is contraindication to the use of general anaesthesia (GA) and is not recommended to be used in any patient suitable for catheter insertion under general anaesthetic. Review of available literature suggests that there is very limited evidence to support that recommendation. Published data supports the role for advanced laparoscopic interventions during catheter insertion in reducing the incidence of catheter malfunction. UK catheter study might highlight some demographic factors contributing to increased catheter failure rate and hence help identify the patients more likely to benefit from advanced laparoscopic insertion. In absence of good quality data to support one technique over the other, our suggestion is to use all available techniques as considered appropriate in the local setting and support research with well-designed RCTs to develop good quality evidence for best ways to establish PD access.

Choice of available catheter insertion techniques might be associated with varying uptake of PD. In the UK Multisite Dialysis Access Audit it was observed that the 23 centres that placed non-surgical PD catheters, 22.0% of incident RRT patients started PD, compared with 20.0% overall. Twenty-seven percent of incident RRT patients started PD at the six centres that placed 90% of their catheters percutaneously. The report also observed that most commonly, responsive PD access pathways were achieved using a predominantly percutaneous rather than surgical catheter insertion approach.⁷⁸ Similar population based data from Canada has also suggested improved PD use in patients who have access to nephrologist-inserted percutaneous PD catheters as compared to surgical (laparoscopic or open) and radiological-inserted catheters.⁸⁰ These registry data suggest association of the unit practices with regards to the insertion techniques and utilisation of PD as modality for RRT but no a causal relationship and should be interpreted accordingly.

UK catheter study has been a commendable effort to understand the UK practice in creating PD access.⁷⁹ Due to the coronavirus pandemic, there was a delay in the long awaited presentation of the outcome and hence we were unable to reference it in the initial draft. The preliminary findings of the study were presented during the ISPD-EUROPD virtual conference in March 2021. These suggest that the outcomes of medical catheters are non-inferior, and using hybrid medical-surgical pathways is economical, even with conservative estimates of which patients have percutaneous PD catheter insertion. We will have to wait for the full analysis of the data, especially to look for difference in different types of complications like mechanical failure or infective complications, and the patient and facility factors that influence the outcomes. We still need similar well designed studies to understand influence of different access pathways in ability of patients access PD in timely manner, and also in minimising morbidity and HD in the interval when there is interruption from PD due to catheter complications.

Nephrologist-initiated PD access programs have had a positive impact on PD penetration. The technique has been associated with good success rate and catheter survival, less postoperative pain, shorter hospital stay, and shorter catheter break-in time compared with the conventional surgical technique. The use of ultrasound to identify the bladder and skin to peritoneum distance can help reduce the risk of visceral injury, although there is no data comparing the outcome of blind insertion to the ones done with radiological guidance. The flexible availability and a short waiting time to have a catheter also make it an attractive option for patients presenting with advanced renal impairment to the renal units and choosing to have PD.^{81,82,83}

The following section reviews the evidence regarding the choice of catheter insertion technique.

Catheter insertion methods include percutaneous needle-guidewire with or without image guidance, open surgical dissection, peritoneoscopic procedures usually performed by the nephrologist, and the surgical laparoscopy. The insertion technique used often depends on the local provider expertise in placing catheters and local availability of material resources. Surgical technique has the advantage of direct visualization, allowing precise catheter placement in the peritoneal cavity. However, this technique is more resource intensive and requires general anaesthesia. In contrast, the percutaneous catheter placement technique could be performed as a bedside procedure using local anaesthesia.⁸⁴

There are few randomised studies to compare the outcomes of these techniques, and even these don't always address the question of technique equivalence in selecting patients equally suited for each technique. Lack of good RCT data has led to a few meta-analyses which include the data from non-randomised trials to improve the comparison of the outcomes, thereby limiting the strength of the evidence.

Percutaneous vs surgical

A few studies have suggested similar or improved outcomes for percutaneously inserted PD catheter as compared to the open surgical insertion.⁸⁵ There was no significant difference in 1-year catheter survival in percutaneous vs surgical PD catheter placement. Catheter dysfunction also did not differ significantly between the groups. The prevalence of peritoneal fluid leak also was similar for percutaneous and surgical groups. However, there was a significant lower incidence of peritonitis among those with percutaneous placement.⁸⁶ The addition of fluoroscopy to the procedure permits confirmation of needle entry into the peritoneal cavity by observing the flow of injected contrast solution around loops of bowel⁵³.

Ultrasonography can be used in conjunction with fluoroscopy with the additional advantage of identifying and avoiding injury to the inferior epigastric vessels and bowel loops⁸⁷. Although this can potentially reduce the risk of immediate complication from the procedure, there is no reason to expect influence of these interventions on long-term catheter related complications.

Another study compared percutaneous insertion with percutaneous insertion guided by radioscopy and surgical insertion of PD catheter in a group of patients comparable for gender, age, body mass index, previous abdominal surgeries, and the prevalence of diabetes mellitus. The incidence of complications including bleeding, catheter dysfunction, exit-site infections and peritonitis was not significantly different among the groups. The catheter survival rate was not significantly different by the end of the follow-up of 19 months.⁸⁸ A recent study of 178 patients compared those with BMI of <28 and >28 kg/m², who had either percutaneous or surgical insertions. This showed the overall one-year catheter survival to be similar in the

two groups but the one-year infection-free catheter survival was superior for patients with BMI > 28 who had the percutaneous technique.⁸⁹

Paediatric studies have also suggested that the percutaneous method reduced the rate of some complications. The onset of dialysis was significantly earlier.⁸⁵

There are 2 meta-analyses reviewing outcomes of percutaneous technique. The first included 2 RCTs and 8 other studies. The pooled data demonstrate no significant difference in 1-year catheter survival between surgical and percutaneous groups. However, the sensitivity analysis of the RCTs demonstrated that the incidence of overall infectious and overall mechanical complications was significantly lower in the percutaneous groups than the surgical groups. The subgroup analyses revealed no significant difference between methods in the rates of peritonitis, tunnel and exit site infection, leakage, inflow-outflow obstruction, bleeding and hernia.⁸⁴

A second meta-analysis sourced data from wider sources, but included no RCTs. There was no significant difference in 1-year catheter survival, catheter dysfunction or the prevalence of peritoneal fluid leak; however, there was a significant lower incidence of peritonitis among those with percutaneous placement.⁸⁶

A recent Cochrane review to evaluate the role of different catheter implantation techniques and catheter types in lowering the risk of PD-related peritonitis in PD patients found that percutaneous insertion compared with open surgical insertion of a PD catheter probably makes little or no difference to exit-site/tunnel infection, early peritonitis, post-operative bleeding (haematoma or haemoperitoneum) or outflow failure.⁹⁰

Assisted PD (aPD) is increasingly used to facilitate dialysis at home, often in those patients who are older and frail and with comorbidities.⁹¹ Unsuitability for safe use of general anaesthesia can be a significant barrier for access to PD for these patients. Percutaneous catheter insertion with the use of local anaesthesia can facilitate use of PD in this group of patients.

Paediatric access

There has been one randomised controlled study comparing percutaneous technique under sedation and local anaesthetic versus open approach under general anaesthesia.⁸⁵ The percutaneous technique was faster and had less complication but the sample was very small. The Renal Association Clinical Practice Guideline - Peritoneal Dialysis – June 2017 recommends that paediatric PD catheter insertions are performed under general anaesthetic.⁹²

Laparoscopic vs open surgical

Open surgical insertion is the most commonly available technique. An early RCT comparing laparoscopic to open surgical insertion reported higher early peritonitis episodes in the open surgical group, most likely related to a higher incidence of exit site leak in the surgical group. Moreover, peritoneoscopically placed catheters were found to have better catheter survival than those placed surgically.⁹³ More recent trials comparing open surgical with laparoscopic insertion suggest no overall difference in the complications or the catheter longevity^{94,95,96}.

Meta-analysis also suggests that the proportion of migrating catheters was lower and the catheter survival was higher in the laparoscopic group^{97,98}. Laparoscopic insertion also significantly decreased the probability of surgical intervention or catheter revision, and obstruction.⁹⁸ The two groups were not significantly different in other catheter-related complications.⁹⁹

Another meta-analysis showed a lower incidence of catheter migration and catheter removal, but a higher incidence of bleeding with a laparoscopic approach than with the open technique. There was no significant difference in the incidence of omentum adhesion, hernia, leakage, intestinal obstruction or peritonitis between the two groups.¹⁰⁰

Small, observational studies have shown that PD catheter insertions can be performed safely and effectively using laparoscopy in children as well, but there are no randomised studies or meta-analyses in this group of patients.^{101,102,103} None of these studies differentiated advanced from “basic” laparoscopic procedures.

Laparoscopic procedure requires use of general anaesthesia (GA) and thereby cannot be used in patients who cannot safely have GA. There are techniques described to allow use of laparoscopic techniques in patients who are not suitable to have PD access under general anaesthetic and are also not suitable for percutaneous PD catheter insertion. Laparoscopic implantation of a PD catheter with N₂O pneumoperitoneum and local anaesthesia has been used in patients and avoids use of GA.¹⁰⁴ Ultrasound-guided transversus abdominis plane (TAP) block has also been successfully used as anaesthesia for PD catheter insertion.¹⁰⁵

Advanced Laparoscopy

Advanced laparoscopic technique involves some additional procedures at the time of PD catheter insertion with an aim to reduce complications and improve catheter outcomes. Various authors have described tunnelling of a port device through the rectus sheath to permit placement of the catheter in a long musculo-fascial tunnel directed toward the pelvis to prevent catheter tip migration, peri-catheter hernias, and reduce the risk of peri-catheter leak.^{106,107,108,109} Other authors have described additional omentopexy^{64,110}, adhesiolysis, resection of epiploic appendices,¹¹⁰ and colopexy^{106,111}. Small studies have shown that PD catheter insertion can usually be successful in patients who had previous abdominal surgery such as appendectomy, ovarian resection, hysterectomy, caesarean section and segmental resection of the small intestine. Laparoscopic adhesiolysis may be necessary and there is a small risk of haemoperitoneum.¹¹² A recent systematic review and meta-analysis examined whether advanced laparoscopic interventions consisting of rectus sheath tunnelling and adjunctive procedures produced a better outcome than open insertion or basic laparoscopy used only to verify the catheter position. This found that, compared with basic laparoscopy, catheter obstruction and migration were significantly lower in the advanced laparoscopic group, whereas the catheter survival was similar in both groups. All outcomes, except catheter obstruction, were similar between the basic laparoscopy and open insertion. Infectious complications such as peritonitis and exit-site infections were similar between the 3 groups.¹¹³

Finally, one study of 231 PD catheter insertions using advanced laparoscopy, basic laparoscopy or open techniques did not show any difference in complications, dysfunction-free PD catheter survival according to obesity.¹¹⁴

Post insertion care

There is very limited observational data reviewing effect of post-insertion care protocols and there is no clear indication that specific interventions have significant advantage in reducing need for intervention.^{13,14} Common practice is to secure the catheter well with self- adhesive non occlusive breathable dressing to avoid traction related trauma to exit site from moving tube, and for the same reason, unnecessary manipulation of tube should be avoided to allow the exit site to heal. This is especially important for patients starting dialysis acutely, where catheter has to be used soon after insertion. In lines with the ISPD guidance to prevent exit site infection, topical antibiotics can be used as prophylaxis.¹⁵

Special situations

Embedded catheter

This implantation technique, developed by Moncrief and Popovich, involves embedding of the external segment of the catheter in the subcutaneous tunnel at insertion, and it is kept embedded for a few weeks before externalization. This procedure allows time for tissue ingrowth into the external cuff and catheter surface between the two cuffs, with the expectation of preventing bacterial colonization of the catheter surfaces from the exit wound and thereby reducing peri-catheter infections. Externalization of embedded catheters is easily accommodated provided that a suitable procedure room is available. Just like the arteriovenous fistula for haemodialysis, this catheter can be inserted in advance and remains embedded in the subcutaneous tunnel. It can be exteriorised electively when the patient needs to start dialysis, thus improving the chances of patients choosing PD for RRT and starting on their preferred modality without the need for temporary haemodialysis through a line. As the catheter has healed completely before being externalised, the chances of leak of PD fluid after commencing PD are also reduced^{115,116}. Reported outcomes of this approach are inconsistent. Some studies have suggested a lower rate of early exit-site infection, leak and obstruction, and a better catheter survival with this technique¹¹⁷, while other studies have failed to show the difference in the infection rates¹¹⁸ and have suggested a high rate of catheter malfunction requiring radiological or surgical/laparoscopic revision procedures¹¹⁹.

There is no data on use of this technique in paediatric population.

Conclusion - Choice of implantation technique

The available evidence is inconclusive on advantage of any technique with regards to patient and catheter outcomes. Authors agreed that not all methods of PD catheter insertion have good quality data to compare and hence support use of any particular technique in preference to the current unit practices. (1C). The evidence for advanced laparoscopic vs laparoscopic procedure is based on cohort studies and a meta-analysis of some cohort studies,¹¹¹ there is more data comparing surgical, laparoscopic and percutaneous insertion. The data shows no significant difference or favours percutaneous insertion.^{113,78,86,22} None of the trials have looked at the advantages of using a single technique versus using a combined approach as observed in the UK catheter study.⁷⁹

Having access to a variety of access techniques including percutaneous and advanced surgical techniques would enable more patients to have access to peritoneal dialysis. Our recommendation of using a

combination of surgical and percutaneous techniques for PD access is based on the review of current evidence and not just due to because of lack surgical expertise or resources.

The limited available data suggest better catheter outcomes with advanced laparoscopic techniques in comparison to standard laparoscopic insertion and the surgeons should have training for these interventions to help improve PD catheter survival in patient with risk of catheter malfunction. Intuitively, patients with previous catheter malfunction could benefit from advanced laparoscopic insertion, but there is no published data to help identify the patients who are at higher risk for developing catheter malfunction. We recommend that the units should have multi-disciplinary approach in the formulation of a patient-centred care plan to optimise PD catheter outcomes, especially in the complex patients.

Registry data from UK and Canadian populations suggests some association of the choice of PD catheter insertion technique with uptake of PD. Percutaneous techniques have the advantage over other techniques in facilitating provision of PD in late presenters. Use of ultrasound guidance or fluoroscopy can reduce the risk of percutaneous PD catheter insertion, especially when done in patients with previous abdominal surgery.

Choice of PD catheter implantation approach should be based upon patient factors, facility resources, and operator expertise, which provides timely PD catheter insertion for patients approaching the need for dialysis, and avoids use of unplanned haemodialysis in these patients.

To improve the patient choice and wider patient access to PD catheter insertion, renal units should develop staff and facilities to provide both percutaneous and surgical PD catheter insertion techniques. Surgical colleagues providing laparoscopic access should aim to provide advanced laparoscopic adjunctive procedures where appropriate and practitioners inserting percutaneous catheters should have ultrasound and/ or fluoroscopic guidance available to improve outcomes. This multi-disciplinary approach would increase the access to PD even in more complicated patients, and help improve the outcomes of PD catheter access.

Paediatric access

Based on observational studies, subtotal omentectomy is recommended is all children who undergo open or laparoscopic PD catheter insertion.^{58,59,60,61,57} A large retrospective cohort study also demonstrates reduced need for catheter revision or replacement by 70%.¹²⁰

Simultaneous abdominal surgical procedures

Hernia repair

2009 RA	No recommendation
2019 ISPD	<ul style="list-style-type: none"> Abdominal wall hernias can be safely repaired at the time of the catheter placement procedure Repair with extra-peritoneal mesh are suggested
2021 UKKA	Agree with guidance
2021 UKKA-P	<ul style="list-style-type: none"> PD fluid in the abdomen makes the diagnosis of Inguinal hernia in male infants more obvious and requires early surgical intervention⁵⁷. In children hernial defects are repaired using sutures only. (1D).

Rationale/ evidence

Abdominal wall hernias can be safely repaired at the time of the catheter placement procedure. If the hernia is complicated and a prolonged healing time is anticipated prior to initiating PD, consider repairing early to allow healing and then PD catheter insertion when the patient is closer to needing dialysis, or combining the hernia repair with catheter embedment, which can be externalised later. Repair of hernias with prosthetic mesh is considered essential for adult patients undergoing PD catheter insertion to minimize risk of recurrence. Intraperitoneal mesh would be susceptible to getting infected in instances of peritonitis; hence an extra-peritoneal mesh repair is suggested.

Inguinal hernia is not necessarily a complication of PD in children; rather the presence of peritoneal fluid unmasks the presence of a hernia. In children hernial defects are repaired using sutures only.

Abdominal vascular prostheses

2009 RA	No recommendation
2019 ISPD	<ul style="list-style-type: none"> Consider allowing 2 weeks after surgical repair of abdominal aortic aneurysm No need to interrupt PD after endovascular repair of aneurysm
2021 UKKA	Agree with guidance
2021 UKKA-P	Not relevant to paediatrics

Rationale/ evidence

The two major concerns with performing PD in patients with an abdominal vascular prosthesis are, in the event of PD-related peritonitis, the graft may become infected by direct extension into the retro-peritoneum, and an associated bacteraemia may result in intravascular seeding of the prosthesis. While both of these routes of graft infection are possible, the occurrence appears to be quite rare.

Published reports describe placement of PD catheters and initiation of dialysis with simultaneous repair of ruptured abdominal aortic aneurysms or at a short interval afterwards, without infection of the prosthesis. Increasing the use of endovascular aortic and iliac artery stent grafting avoids the problem of direct retroperitoneal contamination and allows patients already on PD to continue therapy uninterrupted.

In addition, the significantly lower incidence of bacteraemia associated with PD, as opposed to haemodialysis, makes it a more logical modality choice in patients with prosthetic grafts.

Gastrostomy tubes

2009 RA	No recommendation
2019 ISPD	<ul style="list-style-type: none"> • High risk of severe peritonitis if PEG is inserted in patient on PD • If PD patient requires a PEG, it is recommended that the PD catheter be removed with staged reinsertion after the gastrostomy has had time to heal • Insert new PD catheter 3 to 6 weeks after inserting gastrostomy
2021 UKKA	Agree with guidance
2021 UKKA-P	<ul style="list-style-type: none"> • Gastrostomy placement should ideally take place prior to PD catheter insertion (1D). • In patients already receiving PD, the open surgical procedure is recommended. (not graded). • All patients should be referred to a paediatric surgeon experienced in gastrostomy insertion and the operative approach and peri-operative considerations carefully assessed. (1C).

Rationale/ evidence

There are only individual case reports or small case series describing use of PD in patients with gastrostomy. The use of percutaneous endoscopic gastrostomy (PEG) tubes in patients receiving PD is debated due to

frequent infectious complications. Leakage of peritoneal fluid around the PEG leads to a high rate of fatal peritonitis, especially by fungal organisms.^{121,122} If a PD patient requires a PEG, it is recommended that the PD catheter be removed with staged reinsertion after the gastrostomy has had time to heal¹²². There are reports of successfully retaining catheters without the occurrence of infection by suspending PD for 3 to 6 weeks' healing time under the cover of prophylactic antibiotics, but failures using this approach should be expected^{121,123,124}. Inserting a PD catheter into a patient with an existing PEG is considered relatively safe. The catheter exit site should be located remote from the PEG, on either the opposite side of the abdomen or a pre-sternal exit-site location to reduce the risk of catheter infection¹²².

Very small observational studies have shown that gastrostomy tubes can be inserted in paediatric patients using open and laparoscopic techniques, in a safe manner with a small risk of peritonitis.¹²⁵ The 2012 ISPD guidelines⁷⁷ recommended the preferential use of an open surgical procedure for gastrostomy placement in children who are already receiving PD. A more recent single centre review found that in children already receiving PD, laparoscopic gastrostomy insertion was similar in safety profile and efficacy to open gastrostomy.¹²⁶ Another study, showed no difference in peritonitis in the presence of a gastrostomy, colostomy or vesicostomy on multivariable analysis.¹²⁷

Ongoing / day-to-day care and maintenance of PD access

2021 UKKA	<ul style="list-style-type: none"> • Laxatives should be used to avoid constipation and aim formed soft stool every day (1D) • Catheter should be immobilized with non-occlusive gauze surgical dressing sufficient in size to immobilize the catheter (1D) • Loop the catheter with anchoring tape with no torque to the natural position of the catheter, to prevent trauma and contamination of the exit site (1D) • Consider using Chlorhexidine-impregnated sponge dressing/ Alginate Dressing as an external wound dressing designed to absorb exudate and protect the wound from contamination, after new catheter insertion (1D) • Use Chlorhexidine-impregnated sponge dressing/ topical application of antibiotic (mupirocin or gentamicin) cream or ointment to the catheter exit site at the time of each dressing change(1B)
2021 UKKA-P	<ul style="list-style-type: none"> • Agree with above recommendation

Discussion

Published literature has predominantly focused attention on the practices around PD catheter insertion and their influence on the catheter outcomes. There is very limited data on the effect

of day-to-day practices in the care of PD patients on the technique failure or catheter malfunction. Various factors contribute to catheter loss. Catheter loss due to the mechanical complications leading to poor flow of fluid from the catheter can result in interruption of PD or transfer to HD in up to 20% of patients within first 6 to 12 months of starting PD.^{128,129}

Constipation is a common gastrointestinal disorders among patients with chronic kidney disease partly because of sedentary lifestyle, low fiber and fluid intake, concomitant medications (e.g., phosphate binders, antihypertensive agents), a restricted dietary intake of plant-based fiber-rich foods, and comorbidities (e.g., diabetes, cerebrovascular disease).^{130,131} Some observational data has suggested constipation being less frequent in patients on PD.¹³²

Liberal use of laxatives has been advocated before and during PD training is an underappreciated strategy to promote good catheter function. It is widely accepted that constipation is associated with poor catheter performance, although there is no literature to support this observation. The proposed mechanism is effect of fecal impaction on catheter migration and external compression of the lumen by bowel. It is also proposed that constipation can predispose to bacterial intestinal translocation and eventual enteric peritonitis. Despite the importance of the problem, published literature is scarce, consisting mostly of uncontrolled single-center trials. This inconsistency may be attributed to the large number of clinical, radiological, and endoscopic tools that have been used in the studies with a lack of generally accepted core primary outcomes.¹³³

Patients might have a different perception of their bowel habits and thereby understating of constipation. One study highlighted this discrepancy and suggested use of objective methods like Rome IV criteria for functional constipation or Bristol Stool Form Scale (BSFS) to assess severity of constipation in patients with CKD.¹³⁴ Routine radiological diagnostic and physiological testing is not recommended for chronic constipation.¹³⁵ Pharmacological, dietary, and lifestyle-based approaches are applicable for its treatment, but their effects have not been investigated in patients on dialysis.¹³⁵

The use of laxatives to induce vigorous bowel peristalsis and frequent loose bowel movements are suggested to achieve optimum early catheter function, even in the absence of a history or radiographic findings of constipation.¹³⁶ This should be balanced against the chronic diarrhoea caused by laxative usage, which can be debilitating, especially in the elderly. We suggest tailoring the laxative dose to aim for one soft formed stool every day.

Pulling, twisting and tugging forces applied unintentionally to the catheter during its daily use causes repeated tear and recurrent trauma to the exit site. This can contribute to infection of the exit site and displacement and external extrusion of the catheter cuff.¹³⁷ To promote epithelial in-growth at the exit site, the catheter should be anchored with no torque to the natural position of the catheter. This prevents trauma to the exit site and cuffs, minimizing exposure to bacteria and preventing colonization. The patients should be keep sterile dressing clean, dry and securely taped. Dressing changes following implantation should be restricted to experienced PD staff and are changed weekly unless dressing is sodden or blood stained. Some units use KALTOSTAT® Alginate Dressing as an external wound dressing designed to absorb exudate and protect the wound from contamination.

Patient should be educated to protect their PD access especially during the healing process, to be disturbed as little as possible in first 21 days. Medical teams should use sterile equipment including sterile Ultrasound

gel for investigations, if needed. Patients should be advised to decontaminate mobile phones before exchanges to prevent inadvertent contamination should they answer their phone. We advise the patients to clean home shower heads once a month with descaling solution.

ISPD guidelines to prevent and treat PD catheter related infection recommend prophylactic use of antibiotic on the exit site. This is supported by a number of observational studies, randomized controlled trials, and meta-analyses which confirm that prophylaxis with daily application of mupirocin cream or ointment to the skin around the exit site is effective in reducing Staph aureus exit-site infection (ESI) and possibly peritonitis.⁷⁶ We recommend referring to these guidelines for recommendations to prevent and treat PD catheter related infections.

Recent literature has suggested some advantage of using a Chlorhexidine-impregnated sponge dressing in comparison to historical cohort using gentamicin cream.¹³⁸ 12% patients in this study developed delayed localized contact dermatitis related to Chlorhexidine-impregnated sponge dressing.

Authors practice is of using Chlorhexidine-impregnated sponge dressing/ Alginate Dressing as an external wound dressing designed to absorb exudate and protect the wound from contamination, after new catheter insertion which is changed weekly, till the exit site heals.

Once the exit site is healed the patients should use Chlorhexidine-impregnated sponge dressing or a topical application of antibiotic (mupirocin or gentamicin) cream/ ointment to the catheter exit site at the time of each dressing change.

Data comparing outcomes for patients on PD show significant variation between the units within the United Kingdom and also in comparison with the units internationally. This suggests a significant role of unit practices on these outcomes.¹³⁹ But there is paucity of studies comparing outcomes from specific practices, making it difficult to identify best practices for day-to-day maintenance of PD catheter. Further research is needed to improve the quality of evidence to support future guidelines.

Complications of peritoneal catheters

Infectious complications and management

<p>2009 RA</p>	<ul style="list-style-type: none"> • We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A)
<p>2019 ISPD</p>	<ul style="list-style-type: none"> • We suggest that superficial cuff extrusion be managed by cuff shaving (2C) • We recommend ultrasonographic evaluation of the transmural catheter segment in cases of chronic exit-site infection or when the exit-site infection is responding slowly to treatment, especially for infections involving <i>Staphylococcus aureus</i> and <i>Pseudomonas aeruginosa</i>, and that these findings be used to direct definitive treatment (1B) • We suggest splicing a new catheter segment to the inter-cuff section of the existing catheter and tunnelling it to a more satisfactory exit-site location where an ultrasound exam shows absence of fluid around the superficial cuff and the location of the exit site was a contributing factor to the chronic infection (2C) • We recommend unroofing the tunnel segment with Dacron cuff removal/cuff shaving or simultaneous catheter replacement for clinical or ultrasonographic findings of tunnel infection with fluid around the superficial cuff and the inter-cuff tubing segment (1C) • We recommend catheter removal, interim haemodialysis, and staged reinsertion of the PD catheter for clinical or ultrasonographic evidence of tunnel infection with fluid around the deep cuff or concurrent peritonitis (1B) • We recommend simultaneous catheter replacement for relapsing peritonitis caused by Staphylococcal species if antibiotic therapy resolves abdominal symptoms and the peritoneal cell count is < 100/μL (1A) • Consider tunnelling catheter away from original tunnel in case of simultaneous catheter removal and replacement for infection related complications. (Ungraded)
<p>2021 UKKA</p>	<p>Agree with guidance (2C)</p> <ul style="list-style-type: none"> • Simultaneous catheter removal and insertion should not be done if infecting organism is mycobacteria, fungi, enteric, or <i>Pseudomonas</i> species in origin (2B) • The outcomes of these techniques should be evaluated by local audit to ensure that local expertise in the techniques results in equivalent outcome (not graded)

2021 UKKA-P	Agree with guidance, although in infants and small children cuff extrusion will usually require replacement of catheter rather than re-tunnelling to a new exit-site location
-------------	---

Rationale/ evidence

Infectious and mechanical complications of the peritoneal catheter are the 2 most common reasons for PD failure. With early and appropriate intervention, many catheters can be saved, often without interruption of therapy. On the other hand, in the event of certain infectious complications, it is important to know when urgent removal of the catheter is essential to preserving the peritoneal membrane so patients may return to PD.

2017 ISPD Update on Prevention and Treatment of peritonitis provides a detailed guidance on strategies to prevent and manage infective complications in patients on peritoneal dialysis.⁷⁶ A systematic review and meta-analysis showed Mupirocin and topical antibiotics to be effective in reducing *Staphylococcus aureus* catheter exit site infection in patients having peritoneal dialysis when compared with no treatment or placebo.¹⁴⁰

Shape memory resiliency forces and the proximity of the cuff to the exit site can cause extrusion of the superficial Dacron cuff through the exit site. It soon becomes seeded with bacteria and predisposes the patient to exit-site infection¹⁴¹. The cuff should be gently delivered through the sinus and shaved off the catheter. Purulent discharge or inflammation should be treated appropriately with antibiotics⁷⁶.

Exit site infection not responding to a 2 to 3 weeks treatment as suggested by ISPD guidelines could be associated with tunnel and superficial cuff involvement, which can be confirmed with ultrasound examination of the tunnel^{142,143}. This evaluation requires technician experienced in evaluation of the PD catheter tunnel. If ultrasonography reveals fluid around the superficial cuff, with or without fluid in the inter-cuff section, but without deep cuff involvement or concurrent peritonitis, then this can be managed with un-roofing/cuff shaving or simultaneous catheter replacement^{143,144,145,146,147}. The variations of this procedure are discussed in detail in the ISPD update.²

PD peritonitis should be managed in accordance with previously published guidelines⁷⁶. In patients with refractory peritonitis, simultaneous catheter insertion and removal can be considered if antibiotic treatment resolves clinical signs of infection, the dialysate leukocyte count is < 100/μL, especially if the infecting organism is of staphylococcal sp. and not mycobacteria, fungi, enteric, or *Pseudomonas* species in origin^{148,149}.

Peritoneal leakage and management

2009 RA	No recommendation
2019 ISPD	<ul style="list-style-type: none"> We recommend that initiation of dialysis following catheter placement be delayed for 2 weeks, when possible to minimize the risk of leaks (1B) We recommend that acute and urgent start of PD < 2 weeks following catheter placement utilise a recumbent, low volume intermittent dialysis regimen, leaving peritoneal cavity dry during ambulatory periods to minimize the risk of leak (1C) We recommend the use of CT peritoneography or peritoneal scintigraphy to investigate suspected peritoneal boundary dialysate leaks (1A)
2021 UKKA	Agree with guidance
2021 UKKA-P	<ul style="list-style-type: none"> Agree with guidance in terms of delay of initiation of dialysis if possible; and use of small fill volumes initially (e.g. 8-10 ml/kg). (1D). Use of a continuous layer to close the anterior rectus sheath as well as the placement of extra, interrupted sutures on top can help avoid leaks or even hernias caused by excessive wound tension, due to crying in some of the smaller children. (1C). Tissue glue can be used to help seal surgical incision in babies and infants who have very small abdomens and very little subcutaneous tissue/muscle. (not graded).

Rationale/ evidence

Peritoneal leaks, defined as any dialysate loss from the peritoneal cavity other than through the lumen of the catheter, are arbitrarily classified as early (< 30 days) or late (> 30 days), following catheter implantation and the start of PD. The time period in which the leak occurs may suggest its aetiology^{150,151}.

Early leaks are usually related to catheter implantation technique, the timing of PD initiation, dialysate volumes used, and the strength of abdominal wall tissues. The incidence of peri-catheter leaks is higher with a midline approach to catheter placement than with a paramedian site^{54,55}. No particular insertion technique has been proven to be better at preventing early leak⁸⁶. Delaying start of dialysis for 2 weeks following catheter placement minimizes developing a leak^{152,153,150}. Temporarily discontinuing dialysis for 1 to 3 weeks usually results in spontaneous cessation of an early leak. Dramatic early leaks may indicate purse string suture failure or technical error in wound repair and demands immediate exploration. Leakage through the exit site or insertion incision predisposes to tunnel infection and peritonitis. Prophylactic antibiotic therapy should be considered^{150,154}. Persistent leaks warrant catheter replacement.

Peri-catheter hernias, pseudo-hernias (dialysate-filled peritoneal sac that extends alongside the catheter), or occult tunnel infections with separation of the cuffs from the surrounding tissues are pathways for late leakage around the catheter. Physical strain can be either an early or late cause of peri-catheter leakage. Strenuous physical activities can force dialysate through the abdominal wall around the catheter. Abdominal wall weakness, obesity, steroid use, intraperitoneal pressure, and large dialysate volumes increase the risk of leakage from physical strain^{151,150}. The leak is managed by temporary suspension of dialysis or by supine low-volume dialysate exchanges with a dry peritoneal cavity during ambulatory periods. The risk of leak can be minimized by performing sports and exercise activities with a dry abdomen¹⁵⁵.

In paediatric practice, excessive wound tension, due to crying in some of the smaller children, can result in leaks or even hernias following PD catheter insertion. Use of a continuous layer to close the anterior rectus sheath as well as the placement of extra, interrupted sutures on top can help avoid these problems. Intraoperatively, the leaks can be detected by placing fluid through the PD catheter and filling the abdominal cavity after closure of the sheath. If a leak is detected, extra sutures can be placed before closing the skin. These techniques can also be used in adults where necessary.

Other peritoneal boundary leaks

Other peritoneal cavity leaks could be associated with previously undiagnosed hernias or pleuro-peritoneal connections. Leakage from previously undiagnosed hernias may present as obvious bulges, genital swelling, abdominal wall oedema, or apparent ultrafiltration failure⁽¹⁵⁶⁾. If not revealed on physical exam, occult hernias with leaks may be identified by contrast CT peritoneography or technetium-99^m peritoneal scintigraphy ⁽¹⁵⁶⁾⁽¹⁵⁷⁾. A watertight closure during repair allows patients to continue PD postoperatively without interim haemodialysis. Risk of leak is minimized by using a supine, low-volume, intermittent PD regimen for 2 weeks following repair, leaving the peritoneal cavity dry during ambulatory periods⁽¹⁵⁸⁾.

Pleural Leak

Pleuro-peritoneal connection with leakage of dialysate into the pleural space occurs in 1% – 2% of PD patients. Dyspnoea is frequently the first clinical sign of leak; however, patients may present only with pleuritic pain or a decrease in ultrafiltration. The pleuro-peritoneal leak (PPL) is usually unilateral, most commonly on the right side, and occurs during the first year of PD. A high glucose concentration in a transudate pleural aspirate in a patient on PD developing pleural effusion is suggestive of peritoneo-pleural leak (PPL). Pleural fluid to plasma ratio of >1 or a gradient >0.1mmol/L has shown to be sensitive in diagnosing a pleural leak.¹⁵⁹ The lower glucose gradient does not preclude intraperitoneal dialysate leakage because glucose can be absorbed from the PD fluid and the pleural mesothelial cells could metabolize the pleural fluid glucose, especially if there is an interval between last PD exchange and diagnostic aspiration.¹⁶⁰

Using radionuclide scintigraphy is well described in diagnosing a PPL.¹⁶¹ Technetium 99mTc macro albumin aggregated (99mTc-MAA) infused into peritoneum with PD fluid followed by scintigraphy is a simple, safe and non-invasive method for assessment of PPL with low radiation exposure. The sensitivity and specificity has been reported to be variable.¹⁶²

There is limited described use of CT peritoneogram as a method of confirming a PPL. There is no standardised protocol, but some reports describe a method of using 50-100ml iodinated contrast in 2 litre bag of PD fluid and demonstrating change in contrast enhancement of pleural fluid by increased Hounsfield

units value as compared to a pre-contrast scan after leaving the fluid in abdomen for duration of 1 hour to overnight.^{163,164} There is no data available on sensitivity or specificity of this investigation.

There are some case reports of successful restart of peritoneal dialysis after resting PD of 6 weeks and then restarting with low volume exchanges. Pleurodesis has been used successfully to enable patients to return to PD.¹⁶⁵ There is also description of video assisted thoracoscopic procedure to repair the leak by filling the thoracic cavity with sterile saline, and then inflating peritoneal cavity with carbon dioxide via Tenckhoff catheter. Air bubbles leaking from the diaphragmatic defect identify the leak during thoracoscopic operation enabling repair of the defect followed by pleurodesis.¹⁶⁴

Conservative management (peritoneal rest, low-volume dialysis) is rarely successful. Thoracoscopic pleurodesis with talc poudrage or mechanical rub produces 85% – 100% success rate. Interim haemodialysis is required for approximately 3 weeks following the procedure^{166,167,168,165}.

Flow dysfunction and management

2009 RA	<ul style="list-style-type: none"> We recommend that each PD unit should have the ability to manipulate or re-implant PD catheters when necessary (1B).
2019 ISPD	<ul style="list-style-type: none"> Diagnostic studies and treatment for catheter flow dysfunction should progress in a logical order from conservative or non-invasive approaches to more aggressive interventions (not graded) Choice of intervention for catheter flow dysfunction (radiological manipulation, laparoscopic rescue, or simultaneous catheter replacement) should be based upon patient factors, facility resources, and operator expertise (not graded)
2021 UKKA	<p>Agree with guidance</p> <ul style="list-style-type: none"> Early multi-disciplinary review to agree on the best intervention for definitive solution (1D) Development of pathways to expedite intervention/ surgery to avoid delayed or multiple procedures and also transfer to haemodialysis (1D)
2021 UKKA-P	<p>Agree with guidance</p>

Rationale/ evidence

Flow dysfunction

Constipation contributes to dysfunction of outflow of PD fluid⁴⁵, and should be treated preferably with osmotic laxatives, due to the concern that stimulative laxatives can cause trans-mural migration of bacteria, causing peritonitis⁴⁶. Rarely urinary retention with a distended bladder can also cause similar problems¹⁶⁹. Mechanical kinking of the catheter tubing or an intraluminal fibrin clot is usually accompanied by 2-way obstruction.

Simple abdominal film or a CT scan can be used to recognize a kink in the catheter tubing. The location of the kink will dictate whether revision or catheter replacement is required. After treating constipation and excluding a distended bladder or a kink as the cause of flow issues, then brisk irrigation of the catheter with saline can be tried to dislodge intraluminal debris. Fibrinolytic therapy with tissue plasminogen activator (tPA) may be attempted to clear presumed intraluminal fibrin or blood clots in a dose of 1 mg/mL based upon the calculated volume of the catheter assembly. If catheter obstruction is due to a fibrin or blood clot, recovery of flow function with tPA has been reported at nearly 100%¹⁷⁰.

Catheter migration and tissue attachment

When considering approaches for catheter salvage, it is important to recognize that patients often become frustrated with multiple interventions and interruption of therapy and elect to transfer permanently to haemodialysis. Laparoscopy has the advantage of allowing identification of the underlying condition

producing catheter flow dysfunction, permitting diagnosis-specific management. Laparoscopically enabled interventions have produced long-term clinical success in 63% – 100% of cases^{64,171,172,173,174}. As discussed in catheter insertion techniques, laparoscopic procedures also allow proceeding with additional measures like omentopexy, adhesiolysis, epiploectomy or salpingectomy to prevent recurrence of mechanical problems. Although laparoscopy is a minimally invasive procedure that permits patients to immediately resume PD, it does require general anaesthesia and procedural costs are higher compared with radiological interventions.

Fluoroscopic guidewire, stiff rod, and aluminium bar manipulations have been used to resolve catheter tip migration and extra-luminal and intraluminal obstructions. Clinical success has been described in 46% – 75% of cases in published reports^{175,176}. Radiological manipulation is difficult or impossible to perform through catheters with a preformed arc bend or through long pre-sternal catheters.

Simultaneous replacement of the catheter is also an option, especially if a technical fault in previous insertion is identified, but a new catheter would be subject to the same underlying conditions and also the risks of complications of a new catheter insertion.

There is only observational data looking at the outcomes of all rescue procedures. There is no RCT or even observational cohort data to compare outcomes of surgical versus non-surgical rescue procedures.

External catheter damage

Catheter damage with leak is considered a contaminating event, and investigation for peritonitis is required and prophylactic antibiotics indicated. External splicing repair by the PD nursing staff using commercially available repair kits is possible if at least 2 cm of tubing is present beyond the exit-site¹⁷⁷. Internal splicing repair to the inter-cuff segment can be considered if the catheter tubing is too short for external repair, flow function has been satisfactory, and there is no concurrent peritonitis¹⁷⁸.

Catheter Removal

2009 RA	<ul style="list-style-type: none"> • We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A)
2019 ISPD	<ul style="list-style-type: none"> • Catheters may be removed by either open surgical dissection or “pull technique” (not graded) • We suggest that open surgical dissection removal of the Dacron cuffs intact with the catheter be performed when removal is for a tunnel infection or catheter infection related peritonitis, 2-piece extended catheters joined with a titanium connector, or devices equipped with a Dacron flange and silicone bead fixation components (2C) • We suggest that the “pull technique” is best suited when catheter removal is performed for non-infectious indications where retaining the Dacron cuffs in the tissues is of minimal risk (2C)
2021 UKKA	<ul style="list-style-type: none"> • We recommend that urgent removal of PD catheters should be available where necessary (1A) • We recommend that timely surgical support should be available for the review of PD patients (1A) • Catheters may be removed with dissection and removal both cuffs to avoid future infection risk from the residual cuffs (2C) • We recommend that open surgical dissection removal of the Dacron cuffs intact with the catheter be performed when removal is for a tunnel infection or catheter infection related peritonitis, 2-piece extended catheters joined with a titanium connector, or devices equipped with a Dacron flange and silicone bead fixation components (2C) • We suggest that the “Pull technique” should be used only in circumstances where dissection and removal of cuffs is not possible (not graded)
2021 UKKA-P	<ul style="list-style-type: none"> • Agree as above

Rationale/ evidence

The Dacron cuffs may shear off the tubing during extraction and be retained in the tissues during the “pull technique” commonly performed in the clinic or procedure room with or without local anaesthesia or sedation. The technique is not suitable for catheters with multiple sections or a flange or bead fixation

components. Infection of the retained cuffs necessitating later excision has been reported in 2.5% to 3.2% of cases.^{179,180}

Catheters with evidence of current or past infection, either exit-site or peritonitis, should always be removed with intact dissection and removal of the cuffs and fixation attachments. Cuff removal at the time of the catheter removal is easier in medical catheters as both cuffs are subcutaneous, and can be done under local anaesthesia. It can be difficult to remove cuffs embedded deep under rectus in surgical catheters. If the decision is made to use pull technique to remove the catheter, then this should be clearly documented and the patient informed, so that there is early investigation to explore and remove cuffs in case of complication. Ultrasound is useful to identify and localise the cuffs for removal.

Units need to develop local guidance in agreement with the surgical colleagues to ensure implementation of this recommendation.

Secondary embedding

2009 RA	No recommendation
2019 ISPD	<ul style="list-style-type: none"> We suggest secondary embedding of the PD catheter when renal function has improved enough to stop dialysis but recovery is not expected to be long-term, conditional to previously normal catheter flow function (2D)
2021 UKKA	Agree with guidance
2021 UKKA-P	No recommendation

Rationale/ evidence

There are a few reports of successfully embedding the PD catheter after initial use, when the kidney function has improved enough to stop dialysis, but the improvement is not expected to be long term¹⁸¹. The catheter can be buried subcutaneously provided the catheter has a good flow function. This can then be externalised promptly when needed.

Training

Renal trainees should be encouraged to train in percutaneous PD catheter insertion. Unlike haemodialysis catheter insertion, training opportunities for PD catheter insertion are limited due to lower numbers. Similarly, the surgeons performing PD catheter insertion should train/familiarise with advanced laparoscopic techniques. There is an excellent training initiative from ISPD for surgeons (ISPD University for Surgeons). There should be development of similar training opportunities for percutaneous catheter insertion. There are excellent examples of successful nurse led PD catheter insertion programmes.¹⁸²

We recommend the UK renal community to look at US/ ISN model of developing interventional training centres to provide training in these procedures to interested trainees.

Surgeons involved in laparoscopic PD catheter insertion should be trained in adjunctive components of advanced laparoscopic technique.

Developing good technical skills is dependent on iterative practice. This limits even interested trainees developing confidence in continuing to provide PD access. Use of simulation for training has become significant, alongside the development of laparoscopic techniques, and evidence suggests that skills obtained in simulation are applicable in real clinical scenarios. Simulators are becoming more common, more diverse, more authentic, and increasingly incorporated into education programs and professional practice.¹⁸³ Developing simulators of percutaneous and laparoscopic PD catheter insertion techniques will help in training more colleagues, and hence improve access to PD for the patients.

PD catheter manipulation for malfunctioning catheters is a highly variable practice and various interventions have been described. Radiological and laparoscopic interventions for malpositioned catheter should be part of training for clinicians providing PD access. There is also need for training the PD clinicians in use of ultrasound for evaluation of PD catheter tunnel in patients with ESI.

These are the considerations for the UK renal community to improve training in order to improve outcomes for PD access procedures.

Audit

A regular audit of procedure outcomes and patient complications is essential to support the practice and development of PD programs. Data from renal registry as well as international PD studies shows huge variation in practice and outcomes in PD programs. Poor outcomes from PD catheter insertion and maintenance cause significant morbidity and have major impact on PD utilisation. The time interval between a catheter complication necessitating stopping PD, and bridging it with HD, should be regularly audited with efforts towards minimising it.

Some aspects of care suggested in the guidelines are supported by the best practice consensus amongst experts and might be driven by unique local expertise. Adoption of these recommendations should be supported by local audit process to ensure that the success of these techniques can be reproduced; hence these form part of the recommendation for the audit too.

We recommend a regular in depth audit of PD access related complications/ outcomes to work towards improved methods of ensuring high standards in PD access practice.

- We suggest the creation of perioperative checklists (LocSSIPs) on PD catheter insertion for the different techniques to standardise practice in UK.
- We recommend an audit of catheter insertion outcomes on at least an annual basis as part of a multidisciplinary meeting of the PD team, including attendance of access operators when feasible (1B)
- We suggest audit of timely PD catheter insertion in patients choosing PD as RRT modality
 - Number of patients who had opted for PD as RRT modality requiring to start HD
- We agree with the Audit standards suggested in the ISPD guidelines. Clinical goals specific for the PD access procedure include (2C):
 - Catheter patency at 12 months of > 95% for advanced laparoscopic placement and 80% for all other catheter insertion methods
 - Exit-site/tunnel infection within 30 days of catheter insertion: < 5%
 - Peritonitis within 30 days of catheter insertion: < 5%
 - Visceral injury (bowel, bladder, solid organ): < 1%
 - Significant haemorrhage requiring transfusion or surgical intervention: < 1%
- We suggest that incidences of peri-catheter leaks within 30 days of catheter insertion be recorded separately for early PD starts (< 14 days) and late starts (\geq 14 days) (not graded)
- In addition, we suggest auditing the waiting period for patients requiring a remedial procedure and use of HD during the wait after PD catheter complication
- Instances of failure rate of percutaneous PD catheter insertions and the need to convert to surgical/ advanced laparoscopic PD insertion
- We suggest audit of outcome of interventions on PD catheter (deroofting, retunneling, manipulation for malposition catheters)
- Poor access results in a poor patient experience. We recommend that we work towards developing a system of patient reported outcome measures (PROMs) for PD access.

Definitions

Catheter patency is defined as the percentage or probability of catheter survival at 12 months following placement; therefore, the catheter has not been removed, replaced, or required some type of intervention (surgical or radiological) because of flow dysfunction or irremediable drain pain.

Monitoring of catheter patency for embedded catheters begins at the time of externalization.

Causes of catheter loss are censored, including death, transplant, infection, peri-catheter leakage, or transfers to haemodialysis because of inadequate dialysis, psychosocial reasons, or medical problems.

Future direction and research

In the absence of many good quality RCTs, most of the guidance is based on relatively weak evidence, and expert opinion. There is significant variation in practice between the operators using nominally similar techniques. The procedures described in the guidelines, such as advanced laparoscopic technique, un-roofing/ splicing/ secondary embedding of the catheters, are practiced in only a few units. The available trials have significant limitations as not all use the same end-points to define catheter survival. A lot of research is required with good quality trials to compare the outcomes of various techniques of PD catheter insertion with selection of patient equally suitable for the different techniques using standardised outcome measures, and requires coordination and cooperation between renal units at regional and national level.

UK National Registry for PD catheter insertion

- UK catheter study part of UKPDOPPS is an excellent effort on the part of UK PD community to start to look at variance in practice and outcomes. Consideration should be made by the clinical community involved in PD catheter insertion and care to develop and report nationally all PD insertions and outcomes to gain more knowledge from our current and evolving practice.
- Procedure/ technique level data should be evaluated to compare outcomes and help the units/ operators to learn from best practice.

References

1. Figueiredo A, Goh B-L, Jenkins S, Johnson DW, Mactier R, Ramalakshmi S, et al. *Clinical practice guidelines for peritoneal access*. Perit Dial Int J Int Soc Perit Dial. 2010;**30**(4):424–9.
2. Crabtree JH, Shrestha BM, Chow KM, Figueiredo AE, Povlsen J V., Wilkie M, et al. *Creating and maintaining optimal peritoneal dialysis access in the adult patient: 2019 update*. Perit Dial Int. 2019;**39**(5):414–36.
3. RA Guidelines - *Peritoneal Access* [Internet]. Available from: <https://renal.org/wp-content/uploads/2017/06/peritoneal-access-5th-edition-1.pdf>
4. Warady BA. *Peritoneal dialysis and the pediatric patient*. Perit Dial Int [Internet]. 2012;**32**(4):393–4. Available from: <https://pubmed.ncbi.nlm.nih.gov/22859838>
5. Oxman AD. *Grading quality of evidence and strength of recommendations*. Br Med J. 2004;**328**(7454):1490–4.
6. Flanigan MJ, Gokal R. *Peritoneal catheters and exit-site practices toward optimum peritoneal access: A review of current developments*. Perit Dial Int. 2005;**25**(2):132–9.
7. Domain PS. *Surgical never events taskforce report*. 2014; Available from: <https://improvement.nhs.uk/documents/922/sur-nev-ev-tf.pdf>
8. (UKRR) URR. UK Renal Registry (UKRR) 22nd Annual Report – data to 31/12/2018 [Internet]. Available from: https://www.renalreg.org/wp-content/uploads/2020/07/22nd_UKRR_ANNUAL_REPORT_FULL.pdf
9. Rosansky S, Glasscock RJ, Clark WF. *Early start of dialysis: A critical review*. Vol. 6, Clinical Journal of the American Society of Nephrology. 2011. p. 1222–8.
10. Jain AK, Sontrop JM, Perl J, Blake PG, Clark WF, Moist LM. *Timing of peritoneal dialysis initiation and mortality: Analysis of the canadian organ replacement registry*. Am J Kidney Dis. 2014;**63**(5):798–805.
11. Cooper BA, Branley P, Bulfone L, Collins JF, Craig JC, Fraenkel MB, et al. *A randomized, controlled trial of early versus late initiation of dialysis*. N Engl J Med. 2010;**363**(7):609–19.
12. Johnson DW, Wong MG, Cooper BA, Branley P, Bulfone L, Collins JF, et al. *Effect of timing of dialysis commencement on clinical outcomes of patients with planned initiation of peritoneal dialysis in the ideal trial*. Perit Dial Int. 2012;**32**(6):595–604.
13. Jin H, Fang W, Zhu M, Yu Z, Fang Y, Yan H, et al. *Urgent-start peritoneal dialysis and hemodialysis in esrd patients: Complications and outcomes*. PLoS One. 2016;**11**(11):e0166181.
14. Vasudevan A, Phadke K, Yap H-K. *Peritoneal dialysis for the management of pediatric patients with acute kidney injury*. Pediatr Nephrol. 2017 Jul;**32**(7):1145–56.
15. Ranganathan D, John GT, Yeoh E, Williams N, O’Loughlin B, Han T, et al. *A randomized controlled trial to determine the appropriate time to initiate peritoneal dialysis after insertion of catheter (Timely PD study)*. Perit Dial Int. 2017;**37**(4):420–8.
16. Povlsen J V., Ivarsen P. *How to start the late referred ESRD patient urgently on chronic APD*. Nephrol Dial Transplant. 2006;**21**(SUPPL. 2):ii56-9.
17. Povlsen J V., Sørensen AB, Ivarsen P. *Unplanned start on peritoneal dialysis right after pd catheter implantation for older people with end-stage renal disease*. Vol. 35, Peritoneal Dialysis International. 2015. p. 622–4.
18. Xie J, Kiryluk K, Ren H, Zhu P, Huang X, Shen P, et al. *Coiled versus straight peritoneal dialysis catheters: A randomized controlled trial and meta-analysis*. Am J Kidney Dis. 2011;**58**(6):946–55.

19. See EJ, Cho Y, Hawley CM, Jaffrey LR, Johnson DW. *Early and late patient outcomes in urgent-start peritoneal dialysis*. *Perit Dial Int*. 2017;**37**(4):414–9.
20. Dejardin A, Robert A, Goffin E. *Intraperitoneal pressure in PD patients: Relationship to intraperitoneal volume, body size and PD-related complications*. *Nephrol Dial Transplant*. 2007;**22**(5):1437–44.
21. Crabtree JH, Burchette RJ, Siddiqi NA. *Optimal peritoneal dialysis catheter type and exit site location: An anthropometric analysis*. *ASAIO J*. 2005;**51**(6):743–7.
22. Htay H, Johnson DW. *Catheter Type, Placement, and Insertion Techniques for Preventing Catheter-Related Infections in Maintenance Peritoneal Dialysis Patients: Summary of a Cochrane Review*. *Am J Kidney Dis*. 2019 Nov;**74**(5):703–5.
23. Crabtree JH. *Clinical biodurability of aliphatic polyether based polyurethanes as peritoneal dialysis catheters*. *ASAIO J*. 2003;**49**(3):290–4.
24. Gardezi AI, Schlageter KW, Foster DM, Astor BC, Chan MR, Waheed S. *Erosion of the Silicone Peritoneal Dialysis Catheter with the Use of Gentamicin Cream at the Exit Site*. *Adv Perit Dial*. 2016;**32**:15–8.
25. Hagen SM, Lafranca JA, Ijzermans JNM, Dor FJMF. *A systematic review and meta-analysis of the influence of peritoneal dialysis catheter type on complication rate and catheter survival*. *Kidney Int*. 2014 Apr;**85**(4):920–32.
26. Ouyang CJ, Huang FX, Yang QQ, Jiang ZP, Chen W, Qiu Y, et al. *Comparing the incidence of catheter-related complications with straight and coiled tenckhoff catheters in peritoneal dialysis patients—a single-center prospective randomized trial*. *Perit Dial Int*. 2015;**35**(4):443–9.
27. Yip T, Lui SL, Tse KC, Xu H, Ng FSK, Cheng SW, et al. *A prospective randomized study comparing tenckhoff catheters inserted using the triple incision method with standard swan neck catheters*. Vol. 30, *Peritoneal Dialysis International*. 2010. p. 56–62.
28. Lo WK, Lui SL, Li FK, Choy BY, Lam MF, Tse KC, et al. *A prospective randomized study on three different peritoneal dialysis catheters*. *Perit Dial Int*. 2003;**23**(SUPPL. 2):S127-31.
29. Li CL, Cui TG, Gan HB, Kin C, Lio WI, Kuok UI. *A randomized trial comparing conventional swan-neck straight-tip catheters to straight-tip catheters with an artificial subcutaneous swan neck*. *Perit Dial Int*. 2009;**29**(3):278–84.
30. Eklund B, Honkanen E, Kyllönen L, Salmela K, Kala AR. *Peritoneal dialysis access: Prospective randomized comparison of single-cuff and double-cuff straight Tenckhoff catheters*. *Nephrol Dial Transplant*. 1997;**12**(12):2664–6.
31. Nessim SJ, Bargman JM, Jassal S V. *Relationship between double-cuff versus single-cuff peritoneal dialysis catheters and risk of peritonitis*. *Nephrol Dial Transplant*. 2010;**25**(7):2310–4.
32. Twardowski ZJ. *Presternal peritoneal catheter*. Vol. 9, *Advances in Renal Replacement Therapy*. 2002. p. 125–32.
33. Penner T, Crabtree JH. *Peritoneal dialysis catheters with back exit sites*. *Perit Dial Int*. 2013;**33**(1):93–6.
34. Crabtree JH, Burchette RJ. *Comparative analysis of two-piece extended peritoneal dialysis catheters with remote exit-site locations and conventional abdominal catheters*. *Perit Dial Int*. 2010;**30**(1):46–55.
35. Ta A, Saxena S, Badru F, Lee ASE, Fitzpatrick CM, Villalona GA. *Laparoscopic Peritoneal Dialysis Catheter Placement with Chest Wall Exit Site for Neonate with Stoma*. *Perit Dial Int* [Internet]. 2019 Sep 1;**39**(5):405–8. Available from: <http://www.pdiconnect.com/content/39/5/405.abstract>

36. Warchol S, Roszkowska-Blaim M, Latoszynska J, Jarmolinski T, Zachwieja J. *Experience using presternal catheter for peritoneal dialysis in Poland: a multicenter pediatric survey*. Perit Dial Int J Int Soc Perit Dial. 2003;**23**(3):242–8.
37. Di Paolo N, Capotondo L, Sansoni E, Romolini V, Simola M, Gaggiotti E, et al. *The self-locating catheter: Clinical experience and follow-up*. Perit Dial Int. 2004;
38. Stegmayr BG, Sperker W, Nilsson CH, Degerman C, Persson SE, Stenbaek J, et al. *Few outflow problems with a self-locating catheter for peritoneal dialysis*. Med (United States). 2015;**94**(48).
39. Sanchez-Canel JJ, Garcia-Perez H, Garcia-Calvo R, Pascual MJ, Casado D. *Prospective randomized study comparing a single-cuff self-locating catheter with a single-cuff straight tenckhoff catheter in peritoneal dialysis*. Perit Dial Int. 2016;**36**(1):52–9.
40. Twardowski ZJ, Tully RJ, Fevzi Ersoy F, Dedhia NM. *Computerized tomography with and without intraperitoneal contrast for determination of intraabdominal fluid distribution and diagnosis of complications in peritoneal dialysis patients*. ASAIO Trans. 1990;**36**(2):95–103.
41. Crabtree JH, Chow KM. *Peritoneal Dialysis Catheter Insertion*. Vol. 37, Seminars in Nephrology. 2017. p. 17–29.
42. Twardowski ZJ, Nichols WK, Nolph KD, Khanna R. *Swan neck presternal peritoneal dialysis catheter*. In: Peritoneal Dialysis International. 1993. p. S130-2.
43. Eriguchi M, Tsuruya K, Yoshida H, Haruyama N, Tanaka S, Tsuchimoto A, et al. *Extended Swan-Neck Catheter With Upper Abdominal Exit-Site Reduces Peritoneal Dialysis-Related Infections*. Ther Apher Dial. 2016;**20**(2):158–64.
44. Twardowski ZJ, Prowant BF, Nichols WK, Nolph KD, Khanna R. *Six-year experience with swan neck presternal peritoneal dialysis catheter*. Perit Dial Int. 1998;**18**(6):598–602.
45. Vijt D, Castro MJ, Endall G, Lindley E, Elseviers M. *Post insertion catheter care in peritoneal dialysis (PD) centres across Europe: Part 2: Complication rates and individual patient outcomes*. EDTNA-ERCA J. 2004;**30**(2):91–6.
46. Singharetnam W, Holley JL. *Acute treatment of constipation may lead to transmural migration of bacteria resulting in gram-negative, polymicrobial, or fungal peritonitis*. Perit Dial Int. 1996;**16**(4):423–5.
47. RCS guidance intended to help surgeons and their teams manage the challenges presented by COVID-19 [Internet]. 2020 [cited 2020 Jun 16]. Available from: <https://www.rcseng.ac.uk/coronavirus/>
48. Leaper D, Burman-Roy S, Palanca A, Cullen K, Worster D, Gautam-Aitken E, et al. *Guidelines: Prevention and treatment of surgical site infection: Summary of NICE guidance*. Vol. 337, Bmj. 2008. p. 1049–51.
49. Rouse J, Walker R, Packer S. *Inadvertent intravesical insertion of a Tenckhoff catheter*. Perit Dial Int. 1996;**16**(2):186–7.
50. Gadallah MF, Ramdeen G, Mignone J, Patel D, Mitchell L, Tatro S. *Role of preoperative antibiotic prophylaxis in preventing postoperative peritonitis in newly placed peritoneal dialysis catheters*. Am J Kidney Dis. 2000;**36**(5):1014–9.
51. NHS England. National Safety Standards for Invasive Procedures (NatSSIPs) [Internet]. [cited 2020 Jun 22]. Available from: <https://www.england.nhs.uk/wp-content/uploads/2015/09/natssips-safety-standards.pdf>
52. Vickers R. *Five steps to safer surgery*. Ann R Coll Surg Engl. 2011 Oct;**93**(7):501–3.

53. Abdel-Aal AK, Dybbro P, Hathaway P, Guest S, Neuwirth M, Krishnamurthy V. *Best practices consensus protocol for peritoneal dialysis catheter placement by interventional radiologists*. Vol. 34, Peritoneal Dialysis International. 2014. p. 481–93.
54. Helfrich GB, Pechan BW, Alijani MR. *Reduction of catheter complications with lateral placement*. Perit Dial Bull. 1983;**3**(4 SUPPL.):S2–4.
55. Spence PA, Mathews RE, Khanna R, Oreopoulos DG. *Improved results with a paramedian technique for the insertion of peritoneal dialysis catheters*. Surg Gynecol Obstet. 1985;**161**(6):585–7.
56. Twardowski ZJ. *Peritoneal Catheter Placement and Management*. In: Suki and Massry's THERAPY OF RENAL DISEASES AND RELATED DISORDERS. 1998. p. 953–79.
57. Laakkonen H, Hölttä T, Lönnqvist T, Holmberg C, Rönholm K. *Peritoneal dialysis in children under two years of age*. Nephrol Dial Transplant [Internet]. 2008 May 1;**23**(5):1747–53. Available from: <https://doi.org/10.1093/ndt/gfn035>
58. Lemoine C, Keswani M, Superina R. *Factors associated with early peritoneal dialysis catheter malfunction*. J Pediatr Surg [Internet]. 2019 May 1;**54**(5):1069–75. Available from: <https://doi.org/10.1016/j.jpedsurg.2019.01.042>
59. Ladd AP, Breckler FD, Novotny NM. *Impact of primary omentectomy on longevity of peritoneal dialysis catheters in children*. Am J Surg [Internet]. 2011 Mar 1;**201**(3):401–5. Available from: <https://doi.org/10.1016/j.amjsurg.2010.08.022>
60. LaPlant MB, Saltzman DA, Segura BJ, Acton RD, Feltis BA, Hess DJ. *Peritoneal dialysis catheter placement, outcomes and complications*. Pediatr Surg Int [Internet]. 2018;**34**(11):1239–44. Available from: <https://doi.org/10.1007/s00383-018-4342-1>
61. Cribbs RK, Greenbaum LA, Heiss KF. *Risk factors for early peritoneal dialysis catheter failure in children*. J Pediatr Surg. 2010 Mar;**45**(3):585–9.
62. Jo Y II, Shin SK, Lee JH, Song JO, Park JH. *Immediate initiation of CAPD following percutaneous catheter placement without break-in procedure*. Perit Dial Int. 2007;**27**(2):179–83.
63. Yang YF, Wang HJ, Yeh CC, Lin HH, Huang CC. *Early initiation of continuous ambulatory peritoneal dialysis in patients undergoing surgical implantation of tenckhoff catheters*. Perit Dial Int. 2011;**31**(5):551–7.
64. Crabtree JH, Burchette RJ. *Effective use of laparoscopy for long-term peritoneal dialysis access*. Am J Surg. 2009;**198**(1):135–41.
65. Sharma AP, Mandhani A, Daniel SP, Filler G. *Shorter break-in period is a viable option with tighter PD catheter securing during the insertion*. Nephrology. 2008;**13**(8):672–6.
66. Chow KM, Szeto CC, Leung CB, Kwan BCH, Pang WF, Li PK tao. *Tenckhoff catheter insertion by nephrologists: Open dissection technique*. Perit Dial Int. 2010;**30**(5):524–7.
67. Kang SH, Do JY, Cho KH, Park JW, Yoon KW. *Blind peritoneal catheter placement with a tenckhoff trocar by nephrologists: A single-center experience*. Vol. 17, Nephrology. 2012. p. 141–7.
68. Crabtree JH, Fishman A, Siddiqi RA, Hadnott LL. *The risk of infection and peritoneal catheter loss from implant procedure exit-site trauma*. Perit Dial Int. 1999;**19**(4):366–71.
69. Pommer W, Brauner M, Westphale HJ, Brunkhorst R, Kramer R, Bundschu D, et al. *Effect of a silver device in preventing catheter-related infections in peritoneal dialysis patients: Silver ring prophylaxis at the catheter exit study*. Am J Kidney Dis. 1998;**32**(5):752–60.
70. Crabtree JH, Burchette RJ. *Prospective comparison of downward and lateral peritoneal dialysis catheter tunnel-tract and exit-site directions*. Perit Dial Int. 2006;**26**(6):677–83.
71. Prowant BF, Twardowski ZJ. *Recommendations for exit care*. Perit Dial Int. 1996;**16**(3 SUPPL.):S94–9.

72. Campbell D, Mudge DW, Craig JC, Johnson DW, Tong A, Strippoli GFM. *Antimicrobial agents for preventing peritonitis in peritoneal dialysis patients*. Vol. 2017, Cochrane Database of Systematic Reviews. 2017. p. CD004679.
73. Wikdahl AM, Engman U, Stegmayr BG, Sörenssen JG. *One-dose cefuroxime i.v. and i.p. reduces microbial growth in PD patients after catheter insertion*. *Nephrol Dial Transplant*. 1997;**12**(1):157–60.
74. David N. Bennett-Jones, Jill Martin, Andrew J. Barratt, Terry J. Duffy, Patrick F. Naish GMA. *Prophylactic gentamicin in the prevention of early exit-site infections and peritonitis in CAPD*. *Perit Dial Bull* [Internet]. 1988;**4**:4:147–50. Available from: <http://www.advancesinpd.com/adv88/pt4exitsite88.html>
75. Lye WC, Lee EJC, Tan CC. *Prophylactic antibiotics in the insertion of Tenckhoff catheters*. *Scand J Urol Nephrol*. 1992;**26**(2):177–80.
76. Szeto CC, Li PKT, Johnson DW, Bernardini J, Dong J, Figueiredo AE, et al. *Ispd catheter-related infection recommendations: 2017 update*. *Perit Dial Int*. 2017;**37**(2):141–54.
77. Warady BA, Bakkaloglu S, Newland J, Cantwell M, Verrina E, Neu A, et al. *Consensus guidelines for the prevention and treatment of catheter-related infections and peritonitis in pediatric patients receiving peritoneal dialysis: 2012 update*. *Perit Dial Int J Int Soc Perit Dial*. 2012 Jun;**32** Suppl 2(Suppl 2):S32-86.
78. Hole B, Magadi W, Steenkamp R, Fluck R, Kumwenda M, Wilkie M. *UK renal registry 20th annual report: Chapter 10 2016 multisite dialysis access audit in England, Northern Ireland and Wales and 2015 peritoneal dialysis one year follow-up: National and centre-specific analyses*. *Nephron*. 2018;**139**:253–72.
79. Briggs V, Solis-Trapala I, Wailoo A, McCulloch K, Lambie M, Caskey F, et al. *United Kingdom Catheter Study - Protocol Synopsis*. *Perit Dial Int J Int Soc Perit Dial*. 2018;**38**(2):113–8.
80. Perl J, Pierratos A, Kandasamy G, McCormick BB, Quinn RR, Jain AK, et al. *Peritoneal dialysis catheter implantation by nephrologists is associated with higher rates of peritoneal dialysis utilization: A population-based study*. *Nephrol Dial Transplant*. 2015;**30**(2):301–9.
81. Goh BL. *Nephrologist-Initiated Peritoneal Dialysis Catheter Insertion Programme: A New Paradigm Shift*. In: *Contributions to Nephrology*. 2016. p. 79–84.
82. Asif A, Pflederer TA, Vieira CF, Diego J, Roth D, Agarwal A. *Does catheter insertion by nephrologists improve peritoneal dialysis utilization? A multicenter analysis*. *Semin Dial*. 2005;**18**(2):157–60.
83. Goh BL, Ganeshadeva YM, Chew SE, Dalimi MS. *Does peritoneal dialysis catheter insertion by interventional nephrologists enhance peritoneal dialysis penetration? Semin Dial*. 2008;**21**(6):561–6.
84. Tullavardhana T, Akranurakkul P, Ungkitphaiboon W, Songtish D. *Surgical versus percutaneous techniques for peritoneal dialysis catheter placement: A meta-analysis of the outcomes*. Vol. 10, *Annals of Medicine and Surgery*. 2016. p. 11–8.
85. Merrikhi A, Asadabadi HR, Beigi AA, Marashi SM, Ghaheri H, Zarch ZN. *Comparison of percutaneous versus open surgical techniques for placement of peritoneal dialysis catheter in children: A randomized clinical trial*. *Med J Islam Repub Iran*. 2014;**28**(1):38.
86. Boujelbane L, Fu N, Chapla K, Melnick D, Redfield RR, Waheed S, et al. *Percutaneous versus surgical insertion of PD catheters in dialysis patients: A meta-analysis*. *J Vasc Access*. 2015;**16**(6):498–505.
87. Shanmugalingam R, Makris A, Hassan HC, Li Y, Deguzman I, Nandakoban H, et al. *The utility of sonographic assessment in selecting patients for percutaneous insertion of peritoneal dialysis catheter*. *Perit Dial Int*. 2017;**37**(4):434–42.

88. Chula DC, Campos RP, de Alcântara MT, Riella MC, Do Nascimento MM do. *Percutaneous and surgical insertion of peritoneal catheter in patients starting in chronic dialysis therapy: A comparative study*. *Semin Dial*. 2014;**27**(3):E32-7.
89. Xie D, Zhou J, Cao X, Zhang Q, Sun Y, Tang L, et al. *Percutaneous insertion of peritoneal dialysis catheter is a safe and effective technique irrespective of BMI*. *BMC Nephrol* [Internet]. 2020;**21**(1):199. Available from: <https://doi.org/10.1186/s12882-020-01850-5>
90. Htay H, Johnson DW, Craig JC, Schena FP, Strippoli GF, Tong A, et al. *Catheter type, placement and insertion techniques for preventing catheter-related infections in chronic peritoneal dialysis patients*. *Cochrane database Syst Rev* [Internet]. 2019 May 31;**5**(5):CD004680–CD004680. Available from: <https://pubmed.ncbi.nlm.nih.gov/31149735>
91. Oliver MJ, Quinn RR, Richardson EP, Kiss AJ, Lamping DL, Manns BJ. *Home care assistance and the utilization of peritoneal dialysis*. *Kidney Int*. 2007 Apr;**71**(7):673–8.
92. Renal Association Clinical Practice Guidelines for Peritoneal Dialysis [Internet]. [cited 2020 Jun 16]. Available from: <https://renal.org/wp-content/uploads/2017/06/peritoneal-dialysis-5th-edition-1.pdf>
93. Gadallah MF, Pervez A, El-Shahawy MA, Sorrells D, Zibari G, McDonald J, et al. *Peritoneoscopic versus surgical placement of peritoneal dialysis catheters: A prospective randomized study on outcome*. *Am J Kidney Dis*. 1999;**33**(1):118–22.
94. Jwo SC, Chen KS, Lee CC, Chen HY. *Prospective Randomized Study for Comparison of Open Surgery with Laparoscopic-Assisted Placement of Tenckhoff Peritoneal Dialysis Catheter-A Single Center Experience and Literature Review*. *J Surg Res*. 2010;**159**(1):489–96.
95. Ahmad SF, Liu WJ, Mohd Y, Kandasami ND, Hooi LS, Gunn KB. *Randomized controlled trial of peritoneoscopic vs. Open surgical placement of peritoneal dialysis catheters*. *Perit Dial Int* [Internet]. 2010;**30**:S95-. Available from: <https://www.cochranefulltext.com/central/doi/10.1002/central/CN-01084702/full>
96. van Laanen JHH, Cornelis T, Mees BM, Litjens EJ, van Loon MM, Tordoir JHM, et al. *Randomized controlled trial comparing open versus laparoscopic placement of a peritoneal dialysis catheter and outcomes: The CAPD I trial*. *Perit Dial Int*. 2018;**38**(2):104–12.
97. Hagen SM, Lafranca JA, Steyerberg EW, IJzermans JNM, Dor FJMF. *Laparoscopic versus Open Peritoneal Dialysis Catheter Insertion: A Meta-Analysis*. *PLoS One*. 2013;**8**(2):e56351.
98. Chen Y, Shao Y, Xu J. *The survival and complication rates of laparoscopic versus open catheter placement in peritoneal dialysis patients: A meta-analysis*. *Surg Laparosc Endosc Percutaneous Tech*. 2015;**25**(5):440–3.
99. Qiao Q, Zhou L, Hu K, Xu D, Li L, Lu G. *Laparoscopic versus traditional peritoneal dialysis catheter insertion: a meta analysis*. Vol. 38, *Renal Failure*. 2016. p. 838–48.
100. Sun M-L, Zhang Y, Wang B, Ma T-A, Jiang H, Hu S-L, et al. *Randomized controlled trials for comparison of laparoscopic versus conventional open catheter placement in peritoneal dialysis patients: a meta-analysis*. *BMC Nephrol*. 2020 Feb;**21**(1):60.
101. Kao C-Y, Chuang J-H, Lee S-Y. *A new simplified one-port laparoscopic technique for peritoneal dialysis catheter placement*. *Perit Dial Int J Int Soc Perit Dial*. 2014;**34**(1):109–13.
102. Bıçakcı Ü, Genç G, Tander B, Günaydın M, Demirel D, Özkaya O, et al. *Single port laparoscopic and open surgical accesses of chronic peritoneal dialysis in children: A single center experience over 12 years*. *J Minim Access Surg*. 2016;**12**(2):162–6.

103. Stringel G, McBride W, Weiss R. *Laparoscopic placement of peritoneal dialysis catheters in children.* J Pediatr Surg. 2008 May;**43**(5):857–60.
104. Wu R, Okrainec A, Penner T. *Laparoscopic peritoneal dialysis catheter insertion using nitrous oxide under procedural sedation.* World J Surg. 2015 Jan;**39**(1):128–32.
105. Li Z, Tang XH, Li Q, Zhang W-J, Tao T, Zhu T. *Ultrasound-Guided Oblique Sub-Costal Transversus Abdominis Plane Block as the Principal Anesthesia Technique in Peritoneal Dialysis Catheter Implantation and Plasma Ropivacaine Concentration Evaluation in ESRD Patients: A Prospective, Randomized, Double-Blind Study.* Perit Dial Int J Int Soc Perit Dial. 2018;**38**(3):192–9.
106. Crabtree JH, Fishman A. *A laparoscopic method for optimal peritoneal dialysis access.* Am Surg. 2005;**71**(2):135–43.
107. Ogunc G. *Minilaparoscopic extraperitoneal tunneling with omentopexy: A new technique for CAPD catheter placement.* Perit Dial Int. 2005;**25**(6):551–5.
108. Attaluri V, Lebeis C, Brethauer S, Rosenblatt S. *Advanced laparoscopic techniques significantly improve function of peritoneal dialysis catheters.* J Am Coll Surg. 2010;**211**(6):699–704.
109. Mo M, Ju Y, Hu H, Zhang W, Pan J, Zheng Q, et al. *Peritoneal Dialysis Catheter Emplacement by Advanced Laparoscopy: 8-year Experience from a Medical Center of China.* Sci Rep. 2017;**7**(1):9097.
110. Crabtree JH, Fishman A. *Laparoscopic epiploxy of the greater omentum and epiploic appendices in the salvaging of dysfunctional peritoneal dialysis catheters.* Surg Laparosc Endosc Percutaneous Tech. 1996;**6**(3):176–80.
111. Heithold DL, Duncan TD, White JG LG. *Laparoscopic placement of peritoneal dialysis catheters with medical umbilical fold tunnel formation.* Surg Rounds. 1997;**20**:310–14.
112. Wang J-Y, Chen F-M, Huang T-J, Hou M-F, Huang C-J, Chan H-M, et al. *Laparoscopic assisted placement of peritoneal dialysis catheters for selected patients with previous abdominal operation.* J Invest Surg Off J Acad Surg Res. 2005;**18**(2):59–62.
113. Shrestha BM, Shrestha D, Kumar A, Shrestha A, Boyes SA, Wilkie ME. *Advanced laparoscopic peritoneal dialysis catheter insertion: Systematic review and meta-analysis.* Vol. 38, Peritoneal Dialysis International. 2018. p. 163–71.
114. Krezalek MA, Bonamici N, Kuchta K, Lapin B, Carbray J, Denham W, et al. *Peritoneal dialysis catheter function and survival are not adversely affected by obesity regardless of the operative technique used.* Surg Endosc [Internet]. 2018;**32**(4):1714–23. Available from: <https://doi.org/10.1007/s00464-017-5852-y>
115. Moncrief JW, Popovich RP. *Moncrief-Popovich catheter: Implantation technique and clinical results.* In: Peritoneal Dialysis International. 1994.
116. Dasgupta MK. *Moncrief-Popovich catheter and implantation technique: The AV fistula of peritoneal dialysis.* Vol. 9, Advances in Renal Replacement Therapy. 2002. p. 116–24.
117. Brum S, Rodrigues A, Rocha S, Carvalho MJ, Nogueira C, Magalhães C, et al. *Moncrief-Popovich technique is an advantageous method of peritoneal dialysis catheter implantation.* Nephrol Dial Transplant. 2010;**25**(9):3070–5.
118. Danielsson A, Blohmé L, Tranæus A, Hylander B. *A prospective randomized study of the effect of a subcutaneously “buried” peritoneal dialysis catheter technique versus standard technique on the incidence of peritonitis and exit-site infection.* Perit Dial Int. 2002;**22**(2):211–9.
119. Wu CC, Su PF, Chiang SS. *A prospective study to compare subcutaneously buried peritoneal dialysis catheter technique with conventional technique.* Blood Purif. 2007;**25**(3):229–32.

120. Schuh MP, Nehus E, Ehlal A, Clark SL, Chishti AS, Edwards- Richards AD, et al. *Omentectomy Reduces the Need for Peritoneal Dialysis Catheter Revision in Children : A Study from the Pediatric Nephrology Research Consortium Category : Dialysis*. In: ASN Kidney week 2020. 2020.
121. Dahlan R, Biyani M, McCormick BB. *High mortality following gastrostomy tube insertion in adult peritoneal dialysis patients: Case report and literature review*. Vol. 45, Endoscopy. 2013. p. E313-4.
122. Lew SQ, Gruia A, Hakki F. *Adult peritoneal dialysis patient with Tenckhoff and percutaneous endoscopic gastrostomy catheters*. Perit Dial Int. 2011;**31**(3):360–1.
123. Fein PA, Madane SJ, Jordan A, Babu K, Mushnick R, Avram MM, et al. *Outcome of percutaneous endoscopic gastrostomy feeding in patients on peritoneal dialysis*. Adv Perit Dial. 2001;**17**:148–52.
124. Paudel K, Fan SL. *Successful use of continuous ambulatory peritoneal dialysis in 2 adults with a gastrostomy*. Vol. 64, American Journal of Kidney Diseases. 2014. p. 316–7.
125. Ledermann SE, Spitz L, Moloney J, Rees L, Trompeter RS. *Gastrostomy feeding in infants and children on peritoneal dialysis*. Pediatr Nephrol. 2002 Apr;**17**(4):246–50.
126. Dorman RM, Benedict LA, Sujka J, Sobrino J, Dekonenko C, Andrews W, et al. *Safety of Laparoscopic Gastrostomy in Children Receiving Peritoneal Dialysis*. J Surg Res [Internet]. 2019;**244**:460–7. Available from: <http://www.sciencedirect.com/science/article/pii/S0022480419304822>
127. Sethna CB, Bryant K, Munshi R, Warady BA, Richardson T, Lawlor J, et al. *Risk Factors for and Outcomes of Catheter-Associated Peritonitis in Children: The SCOPE Collaborative*. Clin J Am Soc Nephrol. 2016 Sep;**11**(9):1590–6.
128. Oliver MJ, Perl J, McQuillan R, Blake PG, Jain AK, McCormick B, et al. *Quantifying the risk of insertion-related peritoneal dialysis catheter complications following laparoscopic placement: Results from the North American PD Catheter Registry*. Perit Dial Int J Int Soc Perit Dial. 2020 Mar;**40**(2):185–92.
129. Béchade C, Guittet L, Evans D, Verger C, Ryckelynck J-P, Lobbedez T. *Early failure in patients starting peritoneal dialysis: a competing risks approach*. Nephrol Dial Transplant [Internet]. 2014 Nov **1**;29(11):2127–35. Available from: <https://doi.org/10.1093/ndt/gft055>
130. Sumida K, Yamagata K, Kovesdy CP. *Constipation in CKD*. Kidney Int reports [Internet]. 2019 Nov **13**;5(2):121–34. Available from: <https://pubmed.ncbi.nlm.nih.gov/32043026>
131. Ikee R, Yano K, Tsuru T. *Constipation in chronic kidney disease: it is time to reconsider*. Ren Replace Ther [Internet]. 2019;**5**(1):51. Available from: <https://doi.org/10.1186/s41100-019-0246-3>
132. Yasuda G, Shibata K, Takizawa T, Ikeda Y, Tokita Y, Umemura S, et al. *Prevalence of constipation in continuous ambulatory peritoneal dialysis patients and comparison with hemodialysis patients*. Am J kidney Dis Off J Natl Kidney Found. 2002 Jun;**39**(6):1292–9.
133. Kosmadakis G, Albaret J, Da Costa Correia E, Somda F, Aguilera D. *Constipation in Peritoneal Dialysis Patients*. Perit Dial Int J Int Soc Perit Dial. 2019;**39**(5):399–404.
134. Lee A, Lambert K, Byrne P, Lonergan M. *PREVALENCE OF CONSTIPATION IN PATIENTS WITH ADVANCED KIDNEY DISEASE*. J Ren Care. 2016 Sep;**42**(3):144–9.
135. Tack J, Müller-Lissner S, Stanghellini V, Boeckxstaens G, Kamm MA, Simren M, et al. *Diagnosis and treatment of chronic constipation--a European perspective*. Neurogastroenterol Motil Off J Eur Gastrointest Motil Soc. 2011 Aug;**23**(8):697–710.
136. McCormick BB, Bargman JM. *Noninfectious Complications of Peritoneal Dialysis: Implications for Patient and Technique Survival*. J Am Soc Nephrol [Internet]. 2007 Dec **1**;18(12):3023 LP – 3025. Available from: <http://jasn.asnjournals.org/content/18/12/3023.abstract>

137. Khanna R, Twardowski ZJ. *Peritoneal Catheter Exit Site*. Perit Dial Int [Internet]. 1988 Apr 1;**8**(2):119–23. Available from: <https://doi.org/10.1177/089686088800800202>
138. Htay H, Choo JCJ, Johnson DW, Pascoe EM, Jayaballa M, Oei EL, et al. *Chlorhexidine-impregnated sponge dressing for prevention of catheter exit-site infection in peritoneal dialysis patients: a pilot study*. Int Urol Nephrol. 2021 Apr;**53**(4):803–12.
139. Mehrotra R, Devuyt O, Davies SJ, Johnson DW. *The current state of peritoneal dialysis*. J Am Soc Nephrol. 2016;**27**(11):3238–52.
140. Grothe C, Taminato M, Belasco A, Sesso R, Barbosa D. *Prophylactic treatment of chronic renal disease in patients undergoing peritoneal dialysis and colonized by Staphylococcus aureus: a systematic review and meta-analysis*. BMC Nephrol. 2016 Aug;**17**(1):115.
141. Debowski JA, Wærp C, Kjellevoid SA, Abedini S. *Cuff extrusion in peritoneal dialysis: Single-centre experience with the cuff-shaving procedure in five patients over a 4-year period*. Clin Kidney J. 2017;**10**(1):131–4.
142. Kwan TH, Tong MKAH, Siu YP, Leung KT, Luk SH, Cheung YK. *Ultrasonography in the management of exit site infections in peritoneal dialysis patients*. Nephrology. 2004;**9**(6):348–52.
143. Wu YM, Tsai MK, Chao SH, Tsai TJ, Chang KJ, Lee PH. *Surgical management of refractory exit-site/tunnel infection of Tenckhoff catheter: Technical innovations of partial replantation*. Perit Dial Int. 1999;**19**(5):451–4.
144. Fukasawa M, Matsushita K, Tanabe N, Mochizuki T, Hara T, Takeda M. *A novel salvage technique that does not require catheter removal for exit-site infection*. Perit Dial Int. 2002;**22**(5):618–21.
145. Sakurada T, Okamoto T, Oishi D, Koitabashi K, Sueki S, Kaneshiro N, et al. *Subcutaneous pathway diversion for peritoneal dialysis catheter salvage*. Adv Perit Dial. 2014;**30**:11–4.
146. Crabtree JH. *Peritoneal catheter splicing for distant relocation of poorly selected exit sites*. Perit Dial Int. 2005;**25**(2):192–5.
147. Terawaki H, Nakano H, Ogura M, Kadomura M, Hosoya T, Nakayama M. *Unroofing surgery with en bloc resection of the skin and tissues around the peripheral cuff*. Vol. 33, Peritoneal Dialysis International. 2013. p. 573–6.
148. Crabtree JH, Siddiqi RA. *Simultaneous catheter replacement for infectious and mechanical complications without interruption of peritoneal dialysis*. Perit Dial Int. 2016;**36**(2):182–7.
149. Mitra A, Teitelbaum I. *Is it safe to simultaneously remove and replace infected peritoneal dialysis catheters? Review of the literature and suggested guidelines*. Adv Perit Dial. 2003;**19**:255–9.
150. Leblanc M, Ouimet D, Pichette V. *Dialysate Leaks in Peritoneal Dialysis*. Semin Dial. 2001;**14**(1):50–4.
151. Tzamaloukas AH, Gibel LJ, Eisenberg B, Goldman RS, Kanig SP, Zager PG, et al. *Early and late peritoneal dialysate leaks in patients on CAPD*. Adv Perit Dial. 1990;**6**:64–71.
152. Tzamaloukas AH, Gibel LJ, Eisenberg B, Goldman RS, Kanig SP, Zager PG, et al. *Early and late peritoneal dialysate leaks in patients on CAPD*. Adv Perit Dial. 1990;**6**:64–71.
153. Winchester JF, Kriger FL. *Fluid leaks: Prevention and treatment*. Perit Dial Int. 1994;**14**(SUPPL. 3):S43-8.
154. Holley JL, Bernardini J, Piraino B. *Characteristics and outcome of peritoneal dialysate leaks and associated infections*. Adv Perit Dial. 1993;**9**:240–3.
155. Twardowski ZJ, Khanna R, Nolph KD, Scalamogna A, Metzler MH, Schneider TW, et al. *Intraabdominal pressures during natural activities in patients treated with continuous ambulatory peritoneal dialysis*. Nephron. 1986;**44**(2):129–35.

156. Juergensen PH, Rizvi H, Caride VJ, Kliger AS, Finkelstein FO. *Value of scintigraphy in chronic peritoneal dialysis patients*. *Kidney Int.* 1999;**55**(3):1111–9.
157. Tokmak H, Mudun A, Türkmen C, Şanlı Y, Cantez S, Bozfakioğlu S. *The role of peritoneal scintigraphy in the detection of continuous ambulatory peritoneal dialysis complications*. *Ren Fail.* 2006;**28**(8):709–13.
158. Crabtree JH. *Hernia repair without delay in initiating or continuing peritoneal dialysis*. *Perit Dial Int.* 2006;**26**(2):178–82.
159. Momenin N, Colletti PM, Kaptein EM. *Low pleural fluid-to-serum glucose gradient indicates pleuroperitoneal communication in peritoneal dialysis patients: presentation of two cases and a review of the literature*. *Nephrol Dial Transplant [Internet]*. 2012 Mar 1;**27**(3):1212–9. Available from: <https://doi.org/10.1093/ndt/gfr393>
160. Kennedy C, McCarthy C, Alken S, McWilliams J, Morgan RK, Denton M, et al. *Pleuroperitoneal leak complicating peritoneal dialysis: a case series*. Vol. 2011, *International journal of nephrology*. 2011. p. 526753.
161. Pecoraro JP, Shea LM, Tenorio LE, Graham AD, Watkins GM. *Radioisotope-assisted diagnosis of traumatic rupture of the diaphragm*. *Am Surg.* 1985 Dec;**51**(12):687–9.
162. Harry L, Nyakale N, Tinarwo P. *Scintigraphic peritoneography in the diagnosis of pleuroperitoneal leak complicating peritoneal dialysis: A comparison with conventional diagnostic methods*. *Medicine (Baltimore) [Internet]*. 2020;**99**(32). Available from: https://journals.lww.com/md-journal/Fulltext/2020/08070/Scintigraphic_peritoneography_in_the_diagnosis_of.5.aspx
163. Xu T, Xie J, Wang W, Ren H, Chen N. *Peritoneal-Pleural Leaks Demonstrated by CT Peritoneography*. Vol. 5, *Case reports in nephrology and dialysis*. 2015. p. 135–9.
164. Huang WM, Xu YF, Yang ZK, Zhang SJ, Liu XZ, Li J. *[Diagnosis and thoracoscopic treatment for pleuroperitoneal communication complicating peritoneal dialysis]*. *Zhonghua Yi Xue Za Zhi.* 2018 Jan;**98**(3):213–6.
165. Tang S, Chui WH, Tang AWC, Li FK, Chau WS, Ho YW, et al. *Video-assisted thoracoscopic talc pleurodesis is effective for maintenance of peritoneal dialysis in acute hydrothorax complicating peritoneal dialysis*. *Nephrol Dial Transplant.* 2003;**18**(4):804–8.
166. Nomoto Y, Suga T, Nakajima K, Sakai H, Osawa G, Ota K, et al. *Acute hydrothorax in continuous ambulatory peritoneal dialysis a collaborative study of 161 centers*. *Am J Nephrol.* 1989;**9**(5):363–7.
167. Mak SK, Nyunt K, Wong PN, Lo KY, Tong GMW, Tai YP, et al. *Long-term follow-up of thoracoscopic pleurodesis for hydrothorax complicating peritoneal dialysis*. *Ann Thorac Surg.* 2002;**74**(1):218–21.
168. Chow KM, Szeto CC, Li PKT. *Management Options for Hydrothorax Complicating Peritoneal Dialysis*. Vol. 16, *Seminars in Dialysis*. 2003. p. 389–94.
169. Uchiyama K, Kamijo Y, Yoshida R, Nakatsuka M, Ishibashi Y. *Importance of neurogenic bladder as a cause of drainage failure*. Vol. 36, *Peritoneal Dialysis International*. 2016. p. 232–3.
170. Zorzanello MM, Fleming WJ, Prowant BE. *Use of tissue plasminogen activator in peritoneal dialysis catheters: a literature review and one center's experience*. *Nephrol Nurs J.* 2004;**31**(5):534–7.
171. Krezalek MA, Bonamici N, Lapin B, Carbray JA, Velasco J, Denham W, et al. *Laparoscopic peritoneal dialysis catheter insertion using rectus sheath tunnel and selective omentopexy significantly reduces catheter dysfunction and increases peritoneal dialysis longevity*. *Surg (United States)*. 2016;**160**(4):924–35.
172. Crabtree JH, Burchette RJ. *Peritoneal dialysis catheter embedment: Surgical considerations, expectations, and complications*. *Am J Surg.* 2013;**206**(4):464–71.

173. Ögünç G. *Malfunctioning peritoneal dialysis catheter and accompanying surgical pathology repaired by laparoscopic surgery*. *Perit Dial Int*. 2002;**22**(4):454–62.
174. Ovnat A, Dukhno O, Pinski I, Peiser J, Levy I. *The laparoscopic option in the management of peritoneal dialysis catheter revision*. *Surg Endosc Other Interv Tech*. 2002;**16**(4):698–9.
175. Miller M, McCormick B, Lavoie S, Biyani M, Zimmerman D. *Fluoroscopic manipulation of peritoneal dialysis catheters: Outcomes and factors associated with successful manipulation*. *Clin J Am Soc Nephrol*. 2012 May;**7**(5):795–800.
176. Crabtree JH, Chow KM, Hodgson D, Peters J, Kalsi J, Nathan S, et al. *Sp583 Avoiding the Need for Dialysis Lines: Outcomes of Pre-Emptive Avf Formation - a Single Centre Retrospective Analysis*. *Perit Dial Int [Internet]*. 2017;**31**(1):46–55. Available from: <https://renal.org/wp-content/uploads/2017/06/peritoneal-access-5th-edition-1.pdf>
177. Usha K, Ponferrada L, Prowant BF, Twardowski ZJ. *Repair of chronic peritoneal dialysis catheter*. *Perit Dial Int*. 1998;**18**(4):419–23.
178. Crabtree JH. *Rescue and salvage procedures for mechanical and infectious complications of peritoneal dialysis*. Vol. 29, *International Journal of Artificial Organs*. 2006. p. 67–84.
179. Grieff M, Mamo E, Scroggins G, Kurchin A. *The ‘pull’ technique for removal of peritoneal dialysis catheters: A call for re-evaluation of practice standards*. *Perit Dial Int*. 2017;**37**(2):225–9.
180. Elkabir JJ, Riaz AA, Agarwal SK, Williams G, Elkabir J. *Delayed complications following Tenckhoff catheter removal*. *Nephrol Dial Transplant*. 1999;**14**(6):1550–2.
181. Crabtree JH. *Secondary embedding of peritoneal dialysis catheters*. Vol. 28, *Peritoneal Dialysis International*. Canada; 2008. p. 203–6.
182. Bowes E, Ansari B, Cairns H. *Nurse-Performed Local-Anesthetic Insertions of PD Catheters: One Unit’s Experience*. *Perit Dial Int J Int Soc Perit Dial*. 2016 Nov;**36**(6):589–91.
183. Agha RA, Fowler AJ. *The role and validity of surgical simulation*. *Int Surg*. 2015 Feb;**100**(2):350–7.